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# ANNALS OF OTOLOGY, RHINOLOGY AND LARYNGOLOGY

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## XLVII

### SUBACUTE THYROIDITIS WITH A DISCUSSION OF OTHER TYPES OF THYROIDITIS

DAVID E. BROWN, M.D.

INDIANAPOLIS, IND.

The reasons for the following discussion of subacute thyroiditis are:

1. The relatively large percentage of these patients who first seek attention in an otolaryngologist's office or who are referred there by the general physician.
2. The possible associated causes, forwarded by some authorities, of previous or accompanying upper respiratory, pharyngeal or buccal infections.
3. The frequency with which this disease is misdiagnosed, has needless surgical interference, or is neglected. George Crile, Jr., notes how often the patient is treated for ear disease because of referred pain to the ear and for dental pathology with extraction of teeth to try and relieve the pain referred to the jaw.

The following is a general classification of thyroiditis including not only diseases of the gland caused by infection and injury but also those lesions having only a lymphoid infiltrate; it does not include lymphocytic infiltrations associated with hyperthyroidism or diseases of other endocrine organs:

*Class I—Known etiology.*

- A. Acute infectious thyroiditis.
  1. Suppurative thyroiditis.
  2. Nonsuppurative thyroiditis.

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From the Department of Otolaryngology, Indiana University Medical School.  
Presented as a candidate's thesis to the American Laryngological, Rhinological, and Otolological Society.

- B. Radiation thyroiditis.
- C. Chronic specific thyroiditis.
  - 1. Tuberculosis.
  - 2. Syphilis.
  - 3. Actinomycosis.
  - 4. Sarcoidosis (the etiology is unknown but the lesion is so specific that it would seem to fit best in this group of granulomas).

*Class II*—Unknown etiology but having some histological similarities.

- A. Subacute thyroiditis. Synonyms: de Quervain's thyroiditis, pseudo-tuberculous giant cell thyroiditis, creeping thyroiditis, granulomatous thyroiditis, acute nonsuppurative thyroiditis.
- B. Lymphoid thyroiditis.
- C. Struma lymphomatosa. Synonyms: Hashimoto's struma, lymphadenoid goiter, chronic lymphoid thyroiditis.
- D. Riedel's struma. Synonyms: struma fibrosa, ligneous thyroiditis, eisenharte strumitis.

As briefly as possible I will cover Class I mainly for purposes of differential diagnosis.

#### CLASS I

##### A. ACUTE INFECTIOUS THYROIDITIS

This disease is no respecter of age but is more common in women between the ages of 20 and 40 years. The thyroid gland is quite resistant to infection. The disease usually follows tonsillitis or pharyngitis but may be the result of any sepsis or bacteremia, i.e., pneumonia, influenza, erysipelas, typhoid fever, paratyphoid fever, measles, chicken pox, mumps, etc. The organisms causing suppuration usually are streptococci, staphylococci and pneumococci but other bacteria may be implicated. Over half the reported cases are suppurative.<sup>9</sup> Those associated with viral diseases seldom are. The specific routes of infection are the blood stream, the lymphatics, direct invasion and a persistent thyroglossal duct.

The following is a brief review of the lymphatic drainage of the thyroid gland.<sup>22</sup>

There are six groups of collecting trunks:

- 1. Median superior.
- 2. Median inferior.
- 3-4. Right and left laterals.
- 5. Posterosuperior.
- 6. Posteroinferior.

Briefly in the same order they drain into:

- 1. Superior subdiaphragmatic nodes of the internal jugular chain.
- 2. Pretracheal nodes.

- 3-4. Anterosuperior nodes of the internal jugular chain. The lower right and left lateral trunks terminate in the inferior and lateral nodes of the internal jugular chain.
5. Lateral retropharyngeal nodes.
6. Nodes along the recurrent laryngeal nerve.

Thus, there are common nodes for the lymphatic drainage of the thyroid, pharynx, hypopharynx and the base of the tongue.

Peculiarly, the disease most often starts in the right lobe of the thyroid much as in Link's<sup>10</sup> series of subacute thyroiditis. It has an acute abrupt onset of chills, fever and signs of inflammation of the thyroid gland which is usually acutely tender. The pain over the gland is very severe and there is always a local swelling.<sup>10</sup> The fever ranges from 100.5 to 104.5. The pulse is elevated. The superficial layer of the deep cervical fascia, the pretracheal fascia (visceral or deep layer of deep cervical fascia) and the induration of overlying tissues obscure fluctuation and the outline of the gland. The regional lymph nodes are involved but are often difficult to palpate. The pain may be referred to the ear, mandible or occiput. Swallowing and extension of the neck are difficult and painful so that the patient drools and keeps his head flexed.<sup>10</sup> The most dangerous symptom is dyspnea which occurs in over half the cases and often requires a tracheotomy. The release of pus with the drainage of an abscess located beneath the pretracheal or superficial layer of the deep cervical fascia may be sufficient to relieve the compression of the trachea obviating a tracheotomy.

There is a moderate to marked leukocytosis. The basal metabolic rate is normal or elevated; the latter is from the excessive release of colloid subsequent to follicular epithelial destruction.

The differential diagnosis from subacute thyroiditis, cellulitis, cervical adenitis, perichondritis of the laryngeal cartilages, acute hemorrhage in an adenoma, fulminating malignancy and perhaps Riedel's struma,<sup>10,12</sup> is made by the local and general signs of the infection, aspiration of pus, and biopsy. The disease ordinarily is of much shorter duration than subacute thyroiditis and there is present a cervical adenitis. Needle aspiration for pus may be made with a Vim-Silverman needle facilitating a biopsy, if the diagnosis is in doubt. This should not be done if there is a strong suspicion that one is dealing with an operable carcinoma. In this case surgical exploration and biopsy is the procedure of choice.

Treatment is conservative in the initial stages of the disease with antibiotics and chemotherapeutic agents. It is important to have

a needle aspiration, culture, and determination of sensitivity of the causative organisms early in the disease. An abscess requires surgical drainage. An infected adenoma is best treated by subtotal lobectomy after the acute attack subsides.

The nonsuppurative infectious thyroiditis has never been a very morbid disease, and, with the present-day therapeutic armamentarium, the suppurative disease, if understood and correctly treated, no longer has its former high mortality. Early treatment will usually circumvent a tracheotomy and will prevent an anterior mediastinitis.

#### B. RADIATION THYROIDITIS

Changes produced in the thyroid by radiation are mainly those resulting from radium needles or radioactive iodine ( $I^{131}$ ). External x-ray radiation severe enough to cause capsular thickening will cause ulceration of the overlying skin. Radioactive iodine may cause marked destruction of the follicles, edema, and later dense fibrous tissue replacement. However, the response of the gland to radiation is exceedingly variable. With a severe reaction a tracheotomy may be necessary.

#### C. CHRONIC SPECIFIC THYROIDITIS

1. *Tuberculosis* rarely occurs primarily in the thyroid gland but rather as the accompaniment of a disseminated tuberculosis. The gland is usually hard, bosselated, and fixed. Aspiration reveals thick pus. The diagnosis is made by demonstrating the etiologic agent, and the disease histologically is differentiated from subacute thyroiditis and sarcoidosis by the presence of caseous necrosis.

2. *Syphilis* may present itself as a gumma and more rarely as a diffuse thyroiditis. It is usually unilateral. The swollen gland is smooth or nodular, hard, usually painless and early in the disease is movable but later fixed by infiltration into the surrounding musculature. Pressure symptoms appear late in the disease. Thyroid function is usually undisturbed. The regional nodes may be involved. The differential diagnoses are carcinoma, tuberculosis and Riedel's struma. Biopsy is indicated as diagnosis hinges on histological examination.

3. *Actinomycosis* is very rare and diagnosis depends on finding the organism in the granulomatous lesion or in the discharge.

4. *Sarcoidosis* is also very rare and never is a primary lesion in the thyroid gland. The nodules occurring in the thyroid gland resemble histopathologically the lesions of the disease found elsewhere in the body.

CLASS II

A. SUBACUTE THYROIDITIS

This disease occurs predominantly in women in the ratio of about 6:1<sup>15</sup> to 9:1<sup>16,21</sup> usually between the ages of 25 and 50, but may be present in much older subjects. The average duration is over two months but the condition may be present for over one year.

The increased incidence is mainly because of better recognition. It is, however, my impression and that of a thyroid surgeon, Dr. Goethe Link, that we have been in a cycle which has reached its apex and is now declining.

The onset is ordinarily mild but may be chronic or fulminating. The patient complains to his physician of a sore throat especially on swallowing. During the acute phase the pain usually is referred to the occiput, to the ears or to the mandible. This radiating pain may be the outstanding symptom and is the cause for erroneous diagnoses. It always is said to be distributed over the occipital and greater auricular nerves (C2 and C3), but more probably is vagal and sympathetic in origin. The latter, for the distribution of pain noted, would follow the viscerosensory afferent fibers along the superior thyroid artery from the capsule of the gland to the external carotid artery and thence to the sympathetic trunk and then by the white rami communicantes to the intermediolateral gray matter of the spinal cord at the level of C4 and above. The cervical plexus is too far away to be implicated ordinarily in this disease. Afferent fibers following the inferior thyroid artery probably would not give proper pain distribution although the hook-up in the intermediolateral gray matter of the cervical and upper thoracic cord is not understood too well. Crile, Jr., reports a case with a persistent causalgia which was relieved by stellate ganglion block with procaine. In the more severe fulminating form the onset is quite sudden and is associated with severe pain in the thyroid, a high fever and marked prostration.<sup>2,3</sup> The tachycardia may be out of all proportion to the fever. There may be some slight evidence of thyroid intoxication probably due to rapid absorption of stored colloid in the gland subsequent to the breakdown of the thyroid epithelium. The basal metabolic rate is usually not affected but may be temporarily as high as plus 28 per cent.<sup>3,15</sup>

Link notes that the disease starts in the right lobe in the great majority of his series of 100 cases<sup>16</sup>; this is also reported by de Quervain. The thyroid is enlarged diffusely about one and one-half to two times but has areas of increased swelling and tenderness in only one lobe or parts of a lobe. These painful areas tend to subside with some quiescence of local symptoms only to recur in a different portion



of the gland. Local pressure symptoms are not prominent, but Lindsay and Daily<sup>15</sup> record one case of tracheal obstruction.

It is not uncommon for systemic symptoms to persist long after local tenderness in the thyroid has subsided. A daily elevation of temperature may occur for weeks presenting the problem of fever of unknown origin. Palpation will usually reveal an enlarged, perhaps bosselated thyroid. After subsidence of acute symptoms the patients often feel weak and nervous. They may have a tachycardia, lose weight and give the appearance of hyperthyroidism. In other cases the symptoms resemble those of chronic nervous exhaustion and may be interpreted as functional or due to menopause. When the local symptoms persist in the thyroid after subsidence of the pain, the choking sensation and the feeling of pressure may be interpreted as globus hystericus. A local enlargement may suggest adenoma of the thyroid. In others persistent induration and enlargement of the thyroid may arouse suspicion of malignancy and if only one lobe is involved and is not tender, it is impossible without a biopsy to rule out malignancy.

The sedimentation rate is extremely elevated.

The uptake of radioactive iodine is greatly reduced usually below 10 per cent compared to 30 per cent to 50 per cent by a normal thyroid.<sup>8</sup> There is a normal or high concentration of protein-bound iodine in the plasma. Sources of error in the radioactive iodine uptake result from a) prior ingestion of iodine, gall bladder visualization compounds, I.V. diodrast pyelography or arterial visualization, and lipiodol; b) thyroid medication (desiccated thyroid) which may persist for twelve weeks; c) antithyroid drugs—thiourea, thiocyanate and goitrogens found in foods; d) anterior pituitary failure as from a tumor; e) iodine lack—inadequate ingestion; f) the effect of recent treatment of hyperthyroidism.<sup>25</sup>

The differential diagnoses clinically are: acute infectious thyroiditis, hemorrhage into an adenoma, and carcinoma in the later phase of the thyroiditis.

The diagnosis is dependent on:

1. Typical symptomatic history.
2. Pain in the region of the thyroid plus radiation usually to the ear, occiput or mandible.
3. Fever.
4. A gland enlargement of not more than twice normal with characteristic hard consistency and tenderness and often with evidence of migration of the disease from one part of the gland to another.



5. High sedimentation rate.
6. Low uptake of  $I^{131}$ .
7. Normal or high concentration of protein-bound iodine in the plasma.
8. Needle or surgical biopsy in doubtful cases.

*Etiology.* The cause of this disease is in doubt. Many authors note the high incidence of previous respiratory, pharyngeal, buccal or dental infections prior to the development of this disease.

It would appear that the patient's complaint of a throat infection in most instances arises from pain especially on swallowing. This well could be explained in some as resulting from superior laryngeal and vagal irritation. Portmann's cases treated at the Cleveland Clinic were all examined by the department of otolaryngology and no abnormalities were found.<sup>10</sup> Lindsay and Daily were unable to demonstrate inclusion bodies.<sup>15</sup>

If this disease is a virus infection, the thyroid would have to be involved via the blood stream, through a persistent thyroglossal duct, or by retrograde infection through the lymphatics.

*Pathologic Anatomy.* The gland usually is rather adherent to the surrounding musculature and trachea but shells out cleanly. It may be slightly enlarged or it may be two, perhaps three, times its normal size. There are fibrous tags on the surface of the capsule. "The involved areas are pale, yellow white, avascular, firm, rubbery or hard, tough and may comprise the entire gland or occur as localized areas usually several centimeters in diameter."<sup>9</sup> The lesions are focal in nature but blend into the surrounding tissue. Histologically the gland shows evidence of destruction of the epithelial cells lining the follicles along with marked interfollicular inflammatory tissue reaction. There is a leucocytic infiltration in the edematous stroma; eosinophils are often present in large numbers plus a moderate number of scattered thyroid follicles.<sup>9,15</sup> When the colloid starts to escape into the tissue spaces after the destruction of the epithelial cells, there is a foreign body reaction which attracts histiocytes that phagocytize the colloid with the subsequent production of giant cells. This pseudotuberculous lesion is the most characteristic finding of the disease. Microabscesses are occasionally seen. Fibroblasts proliferate, producing increased fibrosis and density and replacing the early edematous change (Fig. 1).

At present the treatment of choice is cortisone, x-ray and bed rest. Antibiotics have no effect. The predominance of interfollicular inflammatory reaction as the dominant pathologic change would lead

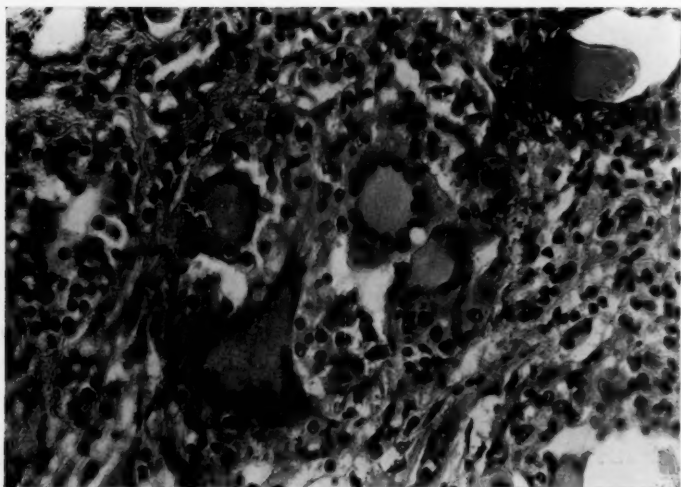


Fig. 1.—Photomicrograph showing typical giant cells in subacute thyroiditis.

one to believe that the anti-inflammatory reaction of cortisone is the source of benefit rather than any hormonal influence on thyroid tissue.<sup>11</sup> Cortisone does not have any effect on the duration of the disease but it does alleviate the severe symptoms and causes the thyroid swelling to disappear.<sup>4,5</sup> The level of dosage should be kept as low as is consistent with therapeutic effect. Efforts to reduce the dosage should be made periodically and the drug stopped when a remission has intervened.

X-ray in the hands of a number of people has been of value. Among these are Crile, Jr., Reeves and Allen, Portmann, Means and King. The usual dosage is approximately 100-150 r, on alternate days for four to six exposures. Crile, Jr., gives a total of 800 r and an additional 1000 r for refractory cases. The lymphocytic infiltration of the gland is the thyroid's typical response to injury. It is the radio sensitive lymphocyte that is probably responsible for the favorable response of this disease to x-ray therapy.

The patients are usually euthyroid on recovery.

In most of my six cases it is difficult to be sure of the origin of the initial pain because the patients were seen after they had had the disease one, two or more weeks.

REPORT OF CASES

A woman aged 45, seen in September 1953, developed thyroiditis in the right lobe five days following a swelling, redness and irritation of the right aryepiglottic fold and the lateral pharyngeal wall. Hypothyroidism with a minus 26 per cent basal metabolism rate and a gain of 18 pounds in weight followed the subsidence of the disease which lasted two and one-half months. This is unusual as most of these cases remain euthyroid.

Another woman aged 40, first seen in June 1954, gave an apparently reliable history of a preceding pharyngitis and generalized aching for 36 hours followed by one asymptomatic day and then the thyroiditis. Over two months later 500 r of x-ray therapy was followed in one week by an exacerbation of symptoms, especially pain and difficulty in swallowing. In three or four days there was a sudden subsidence of all symptoms. The duration in this case was approximately three months.

A woman aged 39, seen in September 1953, had a history of a preceding tonsillitis but this was impossible to verify. Cortisone gave definite relief, but, even though on a maintenance dose sufficient to cause the swelling and symptoms to subside for a period of five weeks, there was an immediate recrudescence of all signs and symptoms of the disease following its discontinuance. She had 800 r of x-ray to the gland in a series of four treatments. This gave no relief. Her disease lasted nine months.

A woman aged 32, examined in June 1948, developed symptoms a few days after a tonsillitis subsided. This started in the right lobe and migrated to the left. Without any therapy except bed rest it subsided in a few weeks.

A man aged 53 was observed in September 1953 with a diffusely tender thyroid following what he stated was a sore throat. As practically all of these people called the disease itself a sore throat, this complaint is difficult to evaluate. Cortisone was given for approximately one week starting with a usual dose of 50 milligrams every six hours for two days, then 25 milligrams every six hours for two days and finally cutting down to 50-100 milligrams a day depending on the maintenance dose required. X-ray therapy was started after he had been on cortisone 48 hours. He had six treatments at five-day intervals with a total of 717 r. Because of a recurrence of symptoms starting four days after the cortisone was stopped, it was resumed in reduced dosage for one week, but his pain was only partially alleviated. He noted that his symptoms gradually diminished with each x-ray treatment. The swelling was longer in disappearing, lasting about three weeks after x-ray was discontinued.

B. STRUMA LYMPHOMATOSA

This disease almost always occurs in women. No other type of thyroid disease demonstrates this peculiar sex incidence to such a great extent. The majority develop during the child-bearing period, but it has been reported at 70 years of age. The average duration is variable but 12 per cent of the patients in Furr and Crile's<sup>6</sup> series had a goiter for 20 or more years.

According to Lindsay<sup>15</sup> and Crile, Jr.,<sup>2</sup> struma lymphomatosa probably is the most common of the disorders under discussion; however, those proven by histological examination are quite scarce at the local hospitals. Since it does not cause severe symptoms, patients do not consult physicians frequently for treatment. In its severer

form it has been operated on and the milder degrees of the disease have not been recognized.

Clinically the irregular lobulation of the thyroid and the tendency to asymmetry usually result in the diagnosis of nodular thyroid and a thyroidectomy is recommended to relieve the symptoms of pressure and vague discomfort in the neck. Myxedema then commonly follows. If a portion of the lateral lobe is involved, it may resemble an enlarged lymph node although it moves with the thyroid on swallowing. The disease is associated with a tendency to hypothyroidism or at least a basal metabolic rate of less than 0 per cent. Nodular goiters usually have a rate above 0 per cent.<sup>2</sup> The gland has a firm rubbery consistency harder than the average nodular thyroid.

The serum protein-bound iodine is generally in the hypothyroid range.

The radioactive iodine uptake is normal according to Crile, Jr., although low values have been reported.<sup>17</sup>

Needle biopsy of the gland with a Vim-Silverman needle is the procedure of choice unless an operable carcinoma is suspected. This is an office procedure.

*Etiology.* This is uncertain but the prevailing thought is that it is probably metabolic in origin. There are a variety of reasons set forth to explain this disease by various authors of which the following are three:

- 1) Increased thyrotropic hormone production by the pituitary.<sup>6</sup>
- 2) Excessive involutionary changes either idiopathic or following a mild or subclinical hyperthyroidism.<sup>14</sup>
- 3) Since the histological picture is that of prolonged thiouracil therapy,<sup>1,18</sup> it has been proposed that the disease represents a pathologic state of the epithelium of the follicle, the cause being unknown, in which it has an inability properly to utilize iodine in the manufacturing of thyroid hormone. The low production of the hormone stimulates the anterior pituitary into producing more thyrotropic hormone resulting in the characteristic histologic changes.

*Pathology.* The gland is two to five times normal size and often symmetrical. It may be slightly adherent to the musculature and trachea but not more so than some toxic goiters. The sectional surface is avascular, often lobulated, with irregular islands of pale yellowish gray separated by widened white fibrous interlobular septa. The uncommon fibrous variety shows very indistinct lobulation and presents a hard fibrous white cut surface.<sup>9</sup>

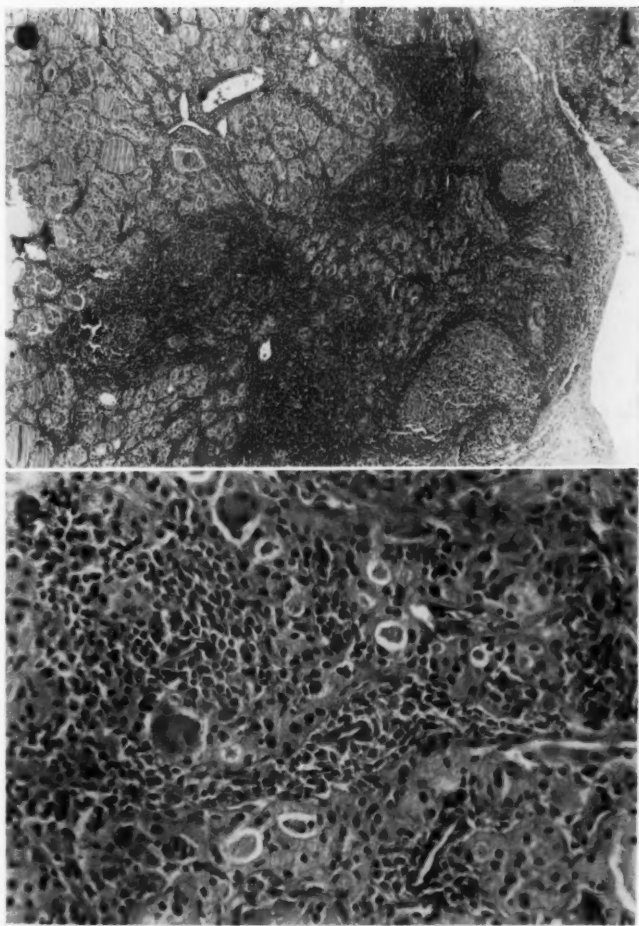


Fig. 2.—Low power showing germinal lymphoid follicles in struma lymphomatosa.

Fig. 3.—High power showing giant cells and oxyphilic degeneration of epithelium.

Histologically there is epithelial degeneration followed by follicular regeneration and reorganization associated with varying degrees of lymphoid infiltration with the presence of germinal lymph follicles and with more or less fibrosis. The epithelium with characteristic oxyphilic changes appears to be in a state of degeneration. Hashimoto in his original paper describes giant cells as part of the picture. These are part of a process of phagocytosis and foreign body reaction to colloid. There are three main types or groups of this disease: 1) those in which lymphoid tissue predominates; 2) those with predominantly fibrous tissue (a more uncommon type comprising perhaps 12 per cent)<sup>13</sup>; and 3) those with a balanced increase of both fibrous and lymphoid tissue<sup>9</sup> (Fig. 2).

Treatment consists of the administration of moderately large doses of desiccated thyroid (3 grains daily) or x-ray therapy given in doses up to a total of 2000 r or both. There is seldom any indication for thyroidectomy.<sup>2</sup> Cortisone gives temporary relief with definite clinical and histological changes but is not a cure.<sup>24</sup>

I have had only one case of struma lymphomatosa, in a woman of 23 years, and it is one of two cases that have been treated by the x-ray department at the Indiana University Medical Center in the past six years. It is interesting that while the biopsy showed a rather typical lesion, the patient complained of pain at intervals and the radioactive iodine uptake was only 3 per cent. This might have been explained partially because only 75 per cent of the radioactive iodine was accounted for, but it is still regarded as being low. She received 1000 r of x-ray with no effect. Because of symptoms of pain and pressure and psychosomatic problems, she eventually had a thyroidectomy. The histological sections taken at this time, approximately five months after the biopsy and two months following x-ray therapy, show even more lymphocytic infiltration (plus the same oxyphilic changes of the epithelium) than the original section. The pain and low radioactive iodine uptake belie the histological sections, pointing more to subacute thyroiditis.

#### C. LYMPHOID THYROIDITIS

Crile, Jr.,<sup>2</sup> believes this may be an early phase of struma lymphomatosa. Graham<sup>7</sup> and Gribetz<sup>8</sup> also consider it a form of Hashimoto's disease. It has the same histological picture except that fibrosis is minimal or absent and the oxyphilic epithelium is not seen or only in small foci. Intrafollicular macrophages are found frequently.

The disease is predominantly in females, from the ages of 20 to 40, frequently developing after childbirth, but it also occurs in

children. There is a gradual or fairly rapid symmetrical enlargement of the thyroid to sometimes three or four times normal size often with mild pressure symptoms.

The radioactive iodine uptake is normal.<sup>9</sup>

There is an elevated serum protein-bound iodine and low butanol-extractable fraction.<sup>8</sup>

Biopsy is essential for accurate diagnosis.

*Etiology.* Crile, Jr., thinks this condition may represent an exhaustion state of the thyroid and that the change in the gland is reversible by putting it at rest. Gribetz<sup>8</sup> and his coworkers believe that by putting the gland at rest with thyroid the reduction in abnormal colloid production from disordered synthesis may be responsible for the improvement of the thyroid epithelium, and that the increased thyroid hormone blood level stops the excessive thyrotropic hormone production of the anterior pituitary.

Treatment consists of moderately large doses of desiccated thyroid (3 grains daily).<sup>2</sup> The enlargement gradually disappears over a period of several months.

#### D. RIEDEL'S STRUMA

This is a very rare disease. It occurs with a slightly greater incidence in women. The age group is approximately 20 to 70 years.<sup>5</sup> According to Crile, Jr.,<sup>2</sup> and Allen Graham,<sup>7</sup> many types of chronic thyroiditis are misnamed Riedel's struma by pathologists. There is often a preceding goiter. The disease described by Riedel is not removable surgically because it involves the entire anterior cervical region of the neck including the thyroid, the strap muscles, the superficial and deep layers of the deep cervical fascia, the carotid sheath and the trachea in a diffuse fibrosis. No one knows positively if the condition starts in the thyroid or in the surrounding tissues, but most evidence would seem to incriminate the gland. There is an iron-hard, non-tender swelling of the thyroid region. These patients almost always are thought to have an inoperable carcinoma of the thyroid prior to biopsy. Their complaints are choking, strangling and respiratory embarrassment from the flattening of the trachea.

The duration of this condition is statistically shorter than struma lymphomatosa, approximately two and one-half years.

The basal metabolic rate is usually normal but may be below normal with extensive destruction of the gland. There may be a slight leucocytosis.



The radioactive iodine uptake is normal.

*Etiology.* This is obscure but it is agreed generally that the disease is an inflammatory rather than a degenerative change. It is often preceded by an adenoma. Few believe now that Riedel's struma is an end stage of subacute thyroiditis, the Lahey group being an exception.<sup>20</sup>

*Pathologic Anatomy.* One and sometimes both lobes of the thyroid may be malformed beyond possible recognition as a gland. There is no dissectable thyroid capsule, it being invaded by the process. (It is of interest that in the experimental production of struma lymphomatosa with thiouracil the capsule of the gland is invaded by the fibroblastic process.) The tissue is gritty and white. The histological changes within the gland are nonspecific and similar to those that may be found in subacute thyroiditis except for an absent or insignificant granulomatous lesion; giant cells are scarce. There is an absence of oxyphilic cells in the epithelium, a loss of lobular structure and an absence of diffuse lymphoid infiltration which distinguishes it from struma lymphomatosa.<sup>9</sup>

Treatments consists of surgical decompression of the trachea, needed to prevent asphyxia. The only thyroid tissue needing removal is that necessary for the decompression, except in the case of a complicating adenoma which should be removed. Operative and post-operative complications are severe. Tracheotomy is often required.

#### CONCLUSION

Pathologists always have had difficulty in segregating struma lymphomatosa, subacute thyroiditis, and the rarely occurring Riedel's struma. Perhaps part of this difficulty arises from the natural foreign body reaction in the thyroid when colloid escapes from an acinus following the degeneration or necrosis of the epithelium, plus the response of the gland to hormones and to injury. Colloid and lipid substances from the thyroid gland cause an inflammatory reaction in the subcutaneous tissue of guinea pigs. The reaction is characterized by the formation of foreign-body giant cells, marked proliferation of fibroblasts and the absence of necrosis. The appearance of the tubercle is almost identical to that seen in subacute thyroiditis. The experimental study indicates that this is caused by fatty acids. These are formed in disintegrating follicles as a result of the hydrolysis of the lipid content of the colloid and of the epithelium. The real problem is identifying the cause for the initial follicular epithelial disease. The evidence would seem to point to a toxin or a virus in the case of subacute thyroiditis and a metabolic disturbance in struma lymphomatosa.



It would seem important that otolaryngologists be aware of this group of diseases not only because of etiological factors but also from the standpoint of diagnosis, treatment and complications, particularly tracheal obstruction.

520 HUME-MANSUR BLDG.

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## XLVIII

### CILIA AND NERVE SUPPLY OF THE ENDOLYMPHATIC SAC OF THE EAR IN CHICK EMBRYOS

CONSUELO SAVÍN V., M.S.

MEXICO, D. F. MEXICO

The sensitive zones of the inner ear's epithelium are characterized by the presence of columnar cells provided with cilia, and covered with elements of a different nature that stimulate them in variable ways. In the static part of the labyrinth we find on maculae, the otolytic membranes formed by crystals of calcium carbonate which are responsible for the stimulation of the underlying nerve fibers. In the case of the cristae, the condensation of the endolymph called cupola ensures the transmission of the pressure changes occurring in the endolymph to the peripheral nerve fibers of the Scarpa's ganglion neurones. In mammals, the auditive region is represented by the lagena, where we can also observe the presence of calcareous bodies on the receptor cells, and in birds a well formed otolith. In mammals we find that the tectorial membrane touches the sensitive cells of Corti's organ, thus performing an important intermediary function between the endolymph and the hearing cells.

In accordance with Wittmaack's<sup>1</sup> theory and Studnicka's<sup>2</sup> researches, it is said that in the inner ear, in all the zones where we can find otoliths, there is an underlying ciliary epithelium with sensitive cells connected to nerve endings.

In chick embryos from the age of seven days of incubation up to hatching, otoliths can be found in the endolymphatic sac,<sup>3</sup> presenting the question whether the epithelium of this zone has at the same time as calcareous structures, ciliated cells or any other form of receptor formations associated to nerve endings. The purpose of this article is to present the results obtained in this respect.

Ten dissections were made of the auditive zone of chick embryos from 9 to 17 days of incubation. When the endolymphatic sac was freed with great care, one could, in every case, observe the presence

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From the National Institute of Cardiology of Mexico, Department of Oto-Rhino-Laryngology.

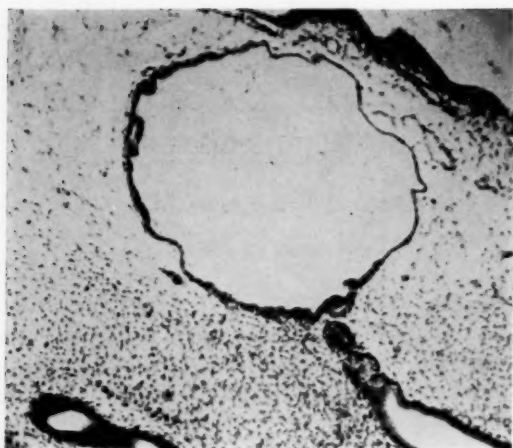


Fig. 1.—Endolymphatic sac of a 9 day embryo. No nerve ending can be seen (paraffin block).

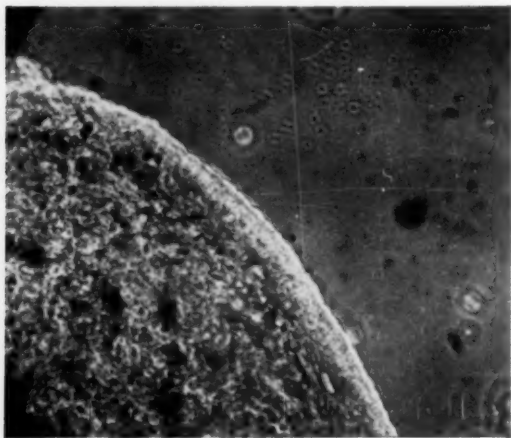


Fig. 2.—Profile of the internal wall of a 12 days embryo. Observation made in fresh material and phase contrast. No cilia can be seen.

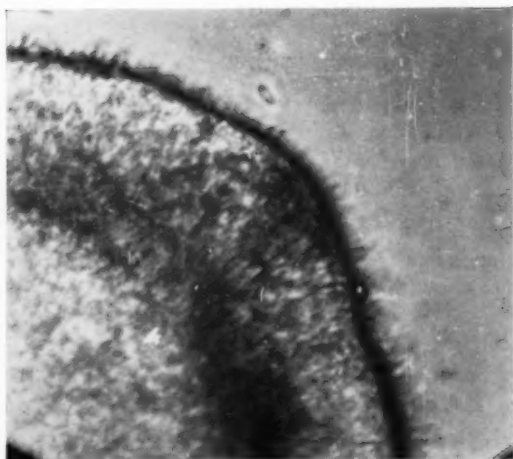


Fig. 3.—Cilia seen on the crest of 12 day embryo in fresh material and phase contrast.

of one of several otoliths. Following the procedure, the endolymphatic sac was dissected in such a way that by folding it the internal surface made a profile line, in order to be able to see it under the high power microscope. Observations were made in phase contrast up to 1250 diameters of magnification and no ciliary formations were found. At the same ages it is possible to see the cilia of the cristae, maculae and lagena with the same procedure and with lower magnification.

Histological series of embryos embedded in paraffin were also made, consistent in age with the material used in the previous dissections. No cilia could be identified in the endolymphatic sac at any age or level of that structure.

The problem of the nerve supply in this zone was solved by these paraffin series stained by the usual hematoxylin-eosine method and by silver impregnations using Cajal's block technique for embryos. The results were the same: no cilia or nerve fibers could be found in relation to the ganglia of the ear or to the nervous structures adjacent to the endolymphatic sac. What could be seen instead, were glandular formations lying mainly on the medial wall.

In accordance with the presented findings, we can say that there are cases where there exists a calcareous body or bodies in the inner

ear, without the presence of sensitive ciliated cells or any special nerve endings.

#### CONCLUSIONS

1. In the endolymphatic sac of chick embryos of ages between nine days of incubation and hatching, using fresh material, the absence of special nerve endings or ciliated cells was proved, in spite of the presence of otoliths.

2. With chick embryos embedded in paraffin and stained with hematoxylin-eosine or by impregnation of silver salts, the same negative results were obtained.

#### INSTITUTO NACIONAL DE CARDIOLOGIA

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## XLIX

### GENERALIZED CHONDRITIS OF BOTH EARS

ALFRED KAHN, JR., M.D.

M. J. KILBURY, SR., M.D.

LITTLE ROCK, ARK.

Chondritis of the ears is seldom generalized. It tends to be localized and is usually not bilateral, unless there is bilateral direct trauma. There is virtually no mention in the literature that we have been able to discover of bilateral symmetrical, general chondritis without direct relationship to trauma. Newcomer, Steffen, Sternberg, and Lichtenstein<sup>1</sup> have published an excellent review of Chondrodermatitis Nodularis Chronica Helicis; they reported 94 cases.

The case reported here was one of chondritis of both ears involving the entire cartilage. There is a relationship to trauma but it is not clear cut. The time of onset differed in the two ears: approximately one or two weeks after exposure to cold for the right ear, and two months for the left ear.

#### REPORT OF A CASE

A 43 year old, white male was first seen on November 19, 1953, complaining of gnawing epigastric pain since 1938. The pain was typical of a duodenal ulcer in most characteristics, and an upper gastro-intestinal study at that time disclosed a well defined ulcer niche. On May 4, 1955, the patient again presented himself, this time with ears red, swollen, and tender for five months. He stated that his ears may first have been injured by a severe sunburn in the summer of 1954, which caused them to peel. The ears did not seem otherwise affected as a result of the sunburn. In December, 1954, the patient sat in his car for a long time on a very cold night and thinks that his ears may have been somewhat frostbitten. Immediately after the exposure, the patient's ears seemed normal. Sometime in December, 1954, his right ear gradually became swollen, red, hot, and tender. The left ear was not affected at that time. In February, 1955, the left ear gradually underwent the same type of painful

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From the University of Arkansas School of Medicine and St. Vincent's Infirmary, Little Rock, Arkansas.

swelling. The patient denied ever having had any previous difficulty of any sort with his ears. In April, 1955, his left eye became intensely bloodshot. It remained that way. The eye was not painful.

He used tobacco and alcohol moderately, and antacid drugs.

The patient wore glasses for presbyopia. He stated that as a child he had had perforated ear drums, but denied any disease of the ears as an adult. He had been told that his thyroid isthmus was enlarged, and on one occasion, had had glycosuria, but with a normal blood sugar.

The patient complained of some stiffness in his knuckles and he had had some pain along the right anterior tibia. He had had a moderate amount of gingivitis, and had asthma as a child. Both ears were markedly swollen and stood out from the head at almost a right angle. The normal contours were completely obscured by the swollen, red, hot, and tender skin. The color might be characterized as a mixture of red and deep violet. The ears appeared more like discs than ears, except for the margins. The usual elasticity was totally absent, and they had a somewhat spongy feel. The external auditory canals were edematous and there was a small amount of whitish discharge. The tympanic membranes were intact. The left conjunctiva was quite injected, the right was not.

The nasal air passages were partially occluded. The mucous membranes of the mouth appeared healthy. The thyroid isthmus was enlarged to approximately twice normal size. There was no lymphadenopathy. The skin was warm and dry.

The serology was negative.

*Complete Blood Count:* Red Blood Cells: 3,780,000. White Blood Cells: 10,150. Hb.: 11. Polymorphonuclears: 63. Lymphocytes: 35. Mononuclears: 1. Eosinophiles: 1. Basophiles: 0. Culture from the external ear showed gram positive cocci. No fungus was obtained.

Reports on biopsy by various pathologists were as follows:

Dr. Hamilton Montgomery, Mayo Clinic: "The slide from the ear of the 45 year old man simply showed a non-specific dermatitis including inflammation of the cartilage. This condition could be chondrodermatitis nodularis chronica helices."

Dr. Herman Pincus, Detroit: "The sections show chondritis and perichondritis. One area of the epidermis shows mild acanthosis and edema, but otherwise the superficial changes which one expects in the typical case of chondrodermatitis nodularis helices are not present. It is, of course, possible that sections of other parts of the block show more 'dermatitis.' It seems to me that the diagnosis chondrodermatitis nodularis chronica helices is primarily a clinical one. Why these painful nodules are so typically located on the uppermost circumference of the helix is unexplained."



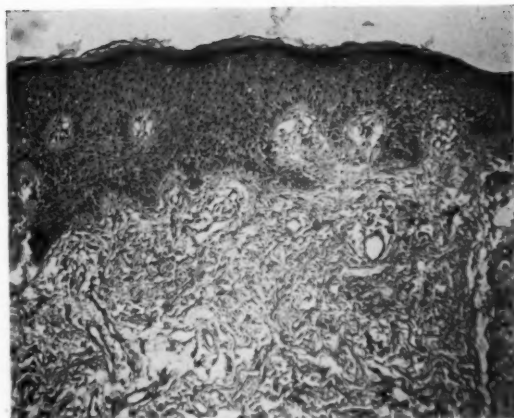


Fig. 1.—Photomicrograph section of auricle, showing skin.

Dr. E. B. Helwig, Washington, D. C.: "The sections which you have forwarded are most interesting, but the changes cannot be recognized as a specific picture other than chondritis and inflammation of the fibrous tissue. The changes do not appear to be those of chondrodermatitis helcis. It is possible that the changes are the result of actinic radiation and could also result from the exposure to cold, as mentioned in your history. Actinic radiation would not be expected to cause changes as deep as the cartilage."

Dr. O. T. Bailey, Indianapolis: "The histology of your patient is typical of chondrodermatitis nodularis chronica helcis. While I infer from your letter that the enlargement of the ears was symmetrical rather than nodular, the nodular quality of the lesion is fairly indicated in the histology and it may be that we are dealing with confluent nodules if the enlargement is symmetrical."

Dr. M. J. Kilbury, Little Rock, stated that he felt that this was a chondritis and could be chondrodermatitis nodularis chronica helcis.

Dr. Stephen Rothman, Chicago: "The slide you sent us was reviewed by Dr. Eleanor Humphreys, Dr. Richard Stoughton and myself. None of us could offer a definite diagnosis. There is extensive disrupting edema of the collagen which shows signs of degenerative changes with new cartilage formation extending peripherally from the main cartilage mass. Our impression was that these are reactive chondroblastoma-like changes with edema and degeneration of collagen."

Various treatments were tried without any apparent relief. A vaccine was made from the material obtained from the ears. A course of this vaccine was given; with each injection, the patient's eyes and ears seemed worse, and it was felt that there might be some relation between the bacteria and the eye and ear disease. Various ointments were without avail. It was reported that lymphedema of the extremities had been successfully treated by the iontophoresis technique

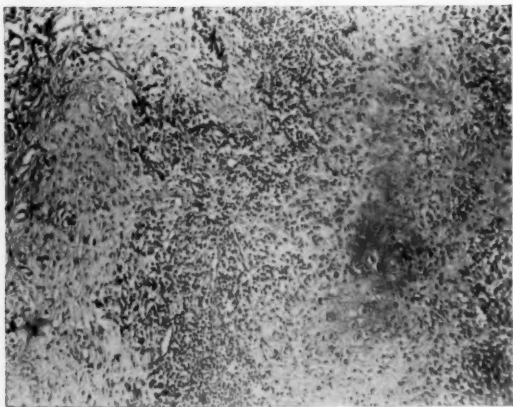


Fig. 2.—Photomicrograph section of auricle, showing cartilage.

using the enzyme hyaluronidase. This was tried without any obvious benefit. At this time, a consultant suggested that the eye condition was distinct from the disease of the ears. He felt that the eye inflammation might be the result of a chronic sinusitis. All treatment was discontinued except that directed to the patient's sinuses. The eye condition improved temporarily and then regressed. No further treatment has been directed to the ears, but they have gradually begun to improve, and the contours and ridges are now visible. The conjunctiva is still injected, and blanches on application of vasoconstrictors.

#### COMMENT

This case has been puzzling from an etiological and therapeutic point of view.

The relationship of this chondritis to trauma is not clearly defined. The patient's ears were sunburned in the summer of 1954, approximately six months before the right ear became sore and swollen. It was eight months before the left ear became involved. In December of 1954, the patient's ears became very cold but were not frozen. It was one week after this episode that the right ear was affected, and two months before the left. These time relationships do not well explain temperature trauma as the immediate cause of the chondritis, although temperature trauma may have been a contributory cause.

The consultant in allergy felt that there might be some causal relationship between the chondritis and the bacteria growing in the external ear canal. An autogenous vaccine was administered; following each injection, there was an increase in the soreness and redness; this was followed by only minimal improvement. There was inflammation of the left eye in April, 1955, and this would intensify after each injection. The cause of the conjunctivitis was disputed; one consultant felt that it was an episcleritis which caused a toxic condition in the body; another felt that it was the result of a polypoid sinusitis of the same side; a third stated that it was allergic. During the course of the local therapy to the sinuses, the eye condition began improving but has since regressed.

This case has been very resistant to treatment. Antibiotic drugs both locally and parenterally proved valueless. Histamine iontophoresis into the ears seemed to produce some beneficial effect, but it was very minor. Surgery such as one might use in a limited chondritis of the ear was not indicated. Cortisone was given locally and orally without success.

The pathology was that of edema of the skin. There was some infiltration with lymphocytes and polymorphonuclear neutrophils. The collagen fibrils showed some fragmentation. The cartilage showed fragmentation and intense infiltration with polynuclears. There was a loss of the usual homogeneous appearance of the cartilage. Several pathologists felt that the histology was that seen in chondrodermatitis nodularis chronica helices. Grossly, the lesions differ in their distribution. Chondrodermatitis nodularis chronica helices is a localized lesion. This lesion is a generalized chondritis of both ears. There are no clues as to the etiology from the histological picture.

1300 W. SIXTH ST.

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## L

### EXTENSIVE VENOUS OBSTRUCTION OF THE LABYRINTH

#### B. VESTIBULAR CHANGES

ROBERT KIMURA, B.A.

H. B. PERLMAN, M.D.

CHICAGO, ILL.

There are relatively few experimental methods for altering the vestibular end organs except by direct trauma or infection (labyrinthitis). Nontraumatic or noninfectious lesions are less frequently available for study. Our understanding of vestibular pathology associated with vestibular disturbances seen in the clinic is therefore very limited. One of the few experimental methods for producing such vestibular lesions is by the administration of streptomycin. This report is concerned with vestibular lesions produced by venous obstruction of the labyrinth. The effect on the auditory end organs has been carefully described in a separate paper.

#### MATERIALS AND METHODS

A total of 38 guinea pigs weighing from 200 to 450 gm were used. Details of the operative procedure and preparation of the specimens were described in the previous report on the cochlea. The animals were carefully observed throughout the postoperative period up to six months for signs of vestibular disturbance. Only one ear was operated in each animal but both ears were processed together with the midbrain. Extra sections were stained and examined in the regions of the ampullae.

#### FINDINGS

*Vestibular Signs.* More than 80 per cent of the postoperative animals demonstrated signs of vestibular disturbance after obstruction of the inferior cochlear vein and some of its tributaries. On awaken-

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From the Division of Otolaryngology of the University of Chicago.

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ing a rapid horizontal nystagmus to the unoperated side was clearly evident. In addition the neck and trunk of the animal was twisted toward the operated side and the animal tended to roll over in this direction. On the second day, the nystagmus rate was reduced about half but the animals continued to show marked asymmetry in tonus of the neck and trunk muscles. They were easily disturbed into vigorous circling movements without falling. By the third day the nystagmus had generally disappeared and the circling movement diminished but remained in some animals as long as ten days after operation.

In addition to the above disturbances the head was tilted with the operated ear lowermost and this position of the head was sometimes retained as long as two months.

*Histological Findings.* In general the animals that showed the greatest degree of vestibular disturbances had the most extensive histological changes in their vestibular end organs. The findings in each end organ will be presented separately.

*Sacculæ.* The sacculæ was the most frequently affected of all the vestibular structures. It was involved as often as the organ of Corti. As in the organ of Corti, the sensory cells were the first to show change. Variations in the degree and extent of damage were marked. The first histological changes could be detected as early as six hours after venous obstruction,

These were pyknosis and fragmentation of the sensory cell nucleus sometimes with edema of the neuroepithelium and separation of the hair cells from the supporting cells (Fig. 1). Similar nuclear changes were often seen in the supporting cells and subepithelial connective tissue. The supporting cell lesion was less extensive than that of the sensory cell. That portion of the sacculæ near the saccular duct was the most frequently involved. Complete degeneration of all the sensory cells of the saccular macula was not observed. Various degrees of displacement of the otolithic membrane and adherence of the adjacent saccular wall were also discernible when compared to the control side (Fig. 2).

Degeneration of the transitional epithelium adjacent to the sensory cells occurred only when the sensory and supporting cells were severely damaged.

No definite change in the volume of the sacculæ could be detected when compared to the opposite normal side. Cellular hyperplasia of the membranous wall of the sacculæ in the region of the displaced otolith was sometimes observed but in general the saccular wall was very resistant to change.

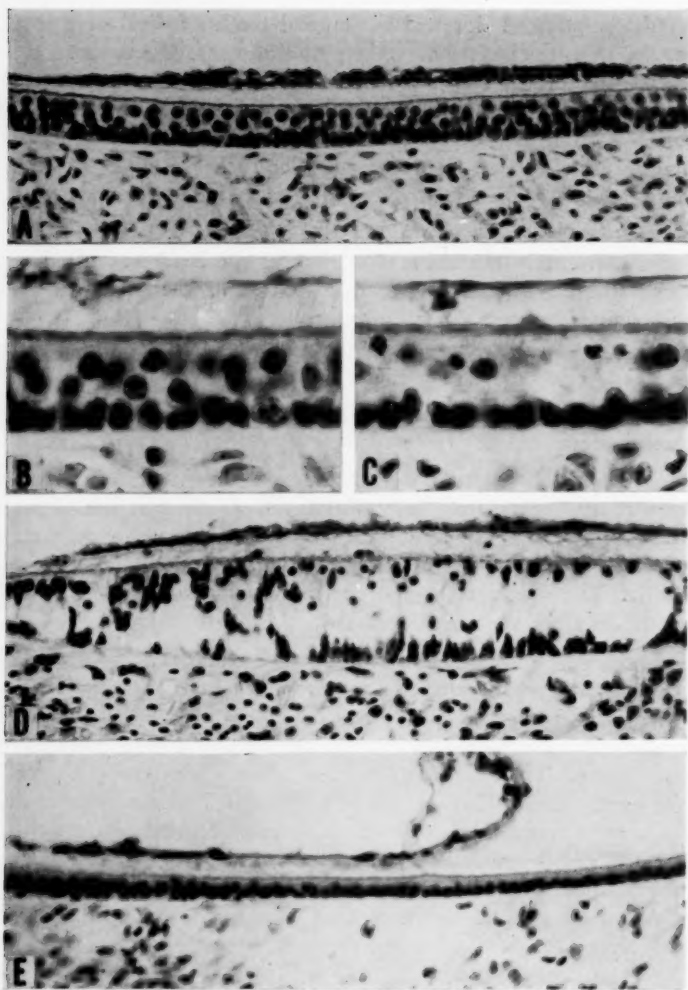


Fig. 1.—Sections through the saccular macula (A, D, E at 330 X) showing: A) Normal. B) Normal, higher power. C) Early degeneration (12 hours), nuclear changes and dissolution of hair cells. D) Edema of the macula and nuclear changes in the subepithelial connective tissue. E) Partial detachment of otolithic membrane. Severe degeneration of hair cells and subepithelial connective tissue. The supporting cells are less affected.

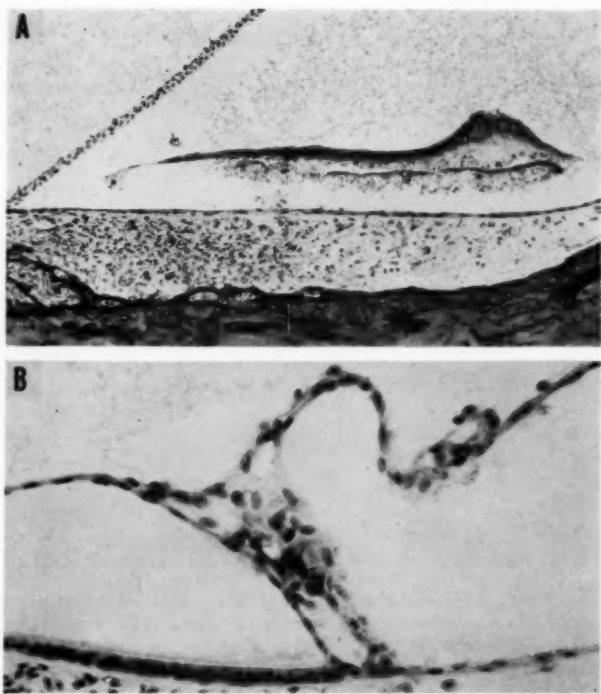


Fig. 2.—A) Displacement of otolithic membrane of the saccule with severe degeneration of the neuroepithelium and subepithelial connective tissue (5 days). B) Remnants of otolithic membrane in adhesion between saccular wall and degenerated macula (1 month).

Hemorrhage was less frequently seen in the saccule than in the cochlear duct and was not in continuity with the latter. It was always associated with hemorrhage into the subepithelial connective tissue and neuroepithelium. In about one week no traces of the hemorrhage could be detected. The fate of this blood was obscure. Cellular fragments were infrequently seen. Unlike the findings in the cochlear duct pigment cell granules were not seen in the saccule. The saccular wall is normally free of pigment cells.

*Utricle.* The utricle was less frequently affected than the saccule. As in the saccule and in the organ of Corti, the sensory cells were the first to show change. The location and extent of the lesions varied greatly and occurred as early as those in the saccule. The



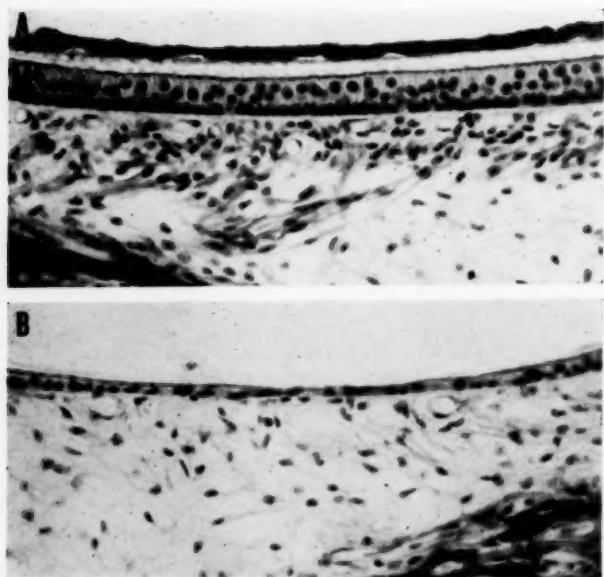


Fig. 3.—Degeneration of utricular macula, otolithic membrane, hair cells, supporting cells, nerve fibers and blood vessels six months after venous obstruction (B). The normal utricle of the corresponding control ear at the same magnification is seen in A.

histological changes generally were similar to those of the saccule including that of the otolithic membrane (Fig. 3). The position of the utricular wall was not affected.

The pigment cells that are normally and regularly distributed along wide areas of the utricular wall showed definite signs of reaction. They moved from their normal position into the trabecular tissue of the perilymphatic space and also into the endolymphatic space. Change in shape of the pigment cells was striking. Pseudopodial and spherical shapes were seen as well as disintegration of the cell with discharge of its pigment granules (Figs. 4 and 7).

The cells of the utricular wall adjacent to the pigment cells also showed changes even near the utriculo-endolymphatic valve. In the H and E stained sections these cells normally contain a few yellow and brown granules. They stain pink with basic fuchsin and in the operated ear were seen in greater concentration than in the normal. This became evident after one month and continued throughout the



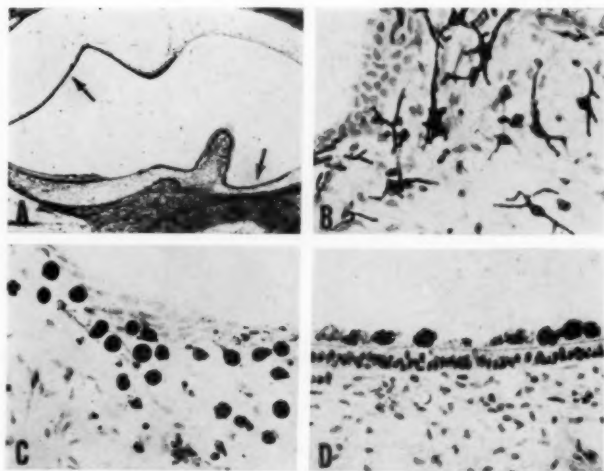


Fig. 4.—Changes in the pigment cells. A) Normal distribution (arrows) of pigment cells along ampulla and utricle (low power). B) Pseudopodial pigment cells migrated to the deeper layers (1 month). C) Spherical pigment cells dispersed below utricular wall (2 months). D) Pigment cells on surface of atrophic macula utriculi (2 months).

period of observation (six months) but appeared to be greatest in the three month old lesion (Fig. 5).

As in the saccule, there was very little blood in the utricle. Unlike the saccule there was extensive hemorrhage in the perilymphatic space surrounding the utricle. This blood was almost completely retained by the trabecular tissue and did not extend into the rest of the perilymphatic space of the vestibule. Some blood could be seen in these areas as long as six months after acute venous obstruction. Both phagocytosis and disintegration of the blood cells occurred.

Cellular fragments and blood cells within the utricle were most commonly seen around the macula and were singularly absent from the region of the utriculo-endolymphatic valve.

*Ampullae.* Lesions of the crista were as common as those of the utricle. No single crista was particularly vulnerable. Histological changes varied in degree and extent. Again the sensory cell showed the first signs of degeneration. The supporting cells and cells of the planum semilunatum were also degenerated in the severe lesions (Figs. 7 and 8). Pigment containing cells were often found imbedded in the cupular substance (Fig. 9). Along with degeneration of

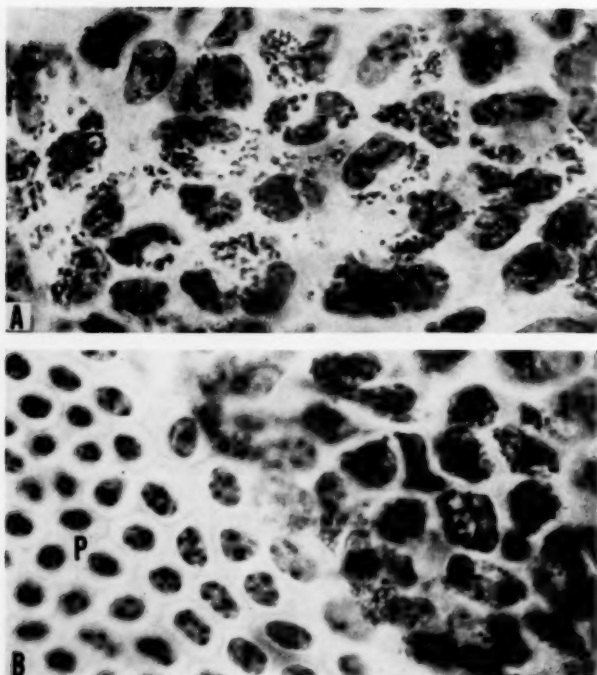


Fig. 5.—A) Cells of utricular wall containing large numbers of granules that stained with basic fuchsin three months after venous obstruction. B) Side wall of ampulla showing the cells of the planum semilunatum (P) adjacent to granule containing cells similar to those in A. (3 months lesion).

the cells of the crista the long hairs and cupular substance disintegrated. The pigment cells of the crista showed changes similar to those of the utricle. They are normally arranged below the epithelial cells at the side of the crista. In the operated ears, these epithelial cells contain a concentration of fine granules similar to those described in the utricle and on their surface cellular fragments were frequently discernible even in the six month lesion.

In severe lesions these granular cells appear to degenerate before those of the planum semilunatum. Extensive hemorrhage within the perilymphatic meshwork around the ampullae was commonly seen but blood cells were rarely seen in the adjacent endolymphatic spaces.

*Canals.* In the semicircular canals the principal acute change, as early as three hours after venous obstruction, was perilymphatic

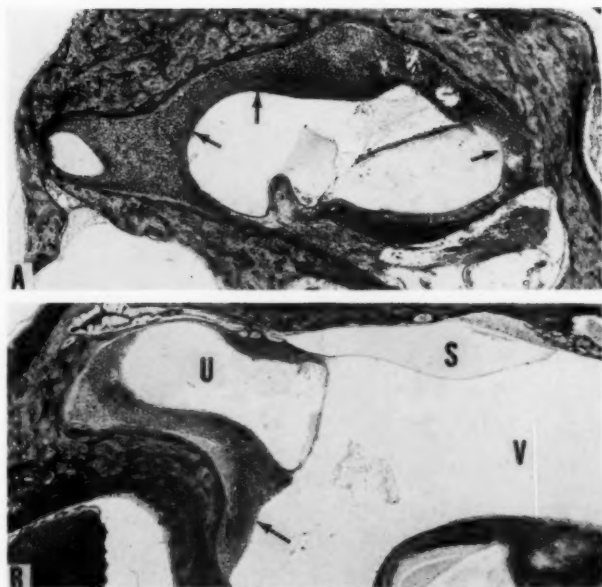


Fig. 6.—A) Severe perilymphatic hemorrhage in vestibular labyrinth (1 day). Note displaced otolithic membrane. Arrows indicate walls of membranous labyrinth. B) Perilymphatic hemorrhage around utricle withheld in the trabecular meshwork (Arrow) (2 days). S. Saccule, U. Utricle, V. Vestibule.

hemorrhage. This varied in degree and location (Fig. 10). Two weeks later fibrosis of the perilymphatic space had begun and one month after acute venous obstruction continued along with varying degrees of ossification throughout the period of observation (six months). The ossification started generally from the endosteal layer and extended towards the membranous canal. Isolated new bone was also observed immediately adjacent to the wall of the membranous canal. When the ossification was extensive, the perilymphatic space was found completely occluded with new bone. In some cases bone formation within the canal completely obliterated the endolymphatic space. These changes took place with or without apparent changes in the cells of the cristae.

In the superior and horizontal canals the labyrinth capsule adjacent to the dura and the middle ear became thin and in one case was replaced by fibrous tissue.

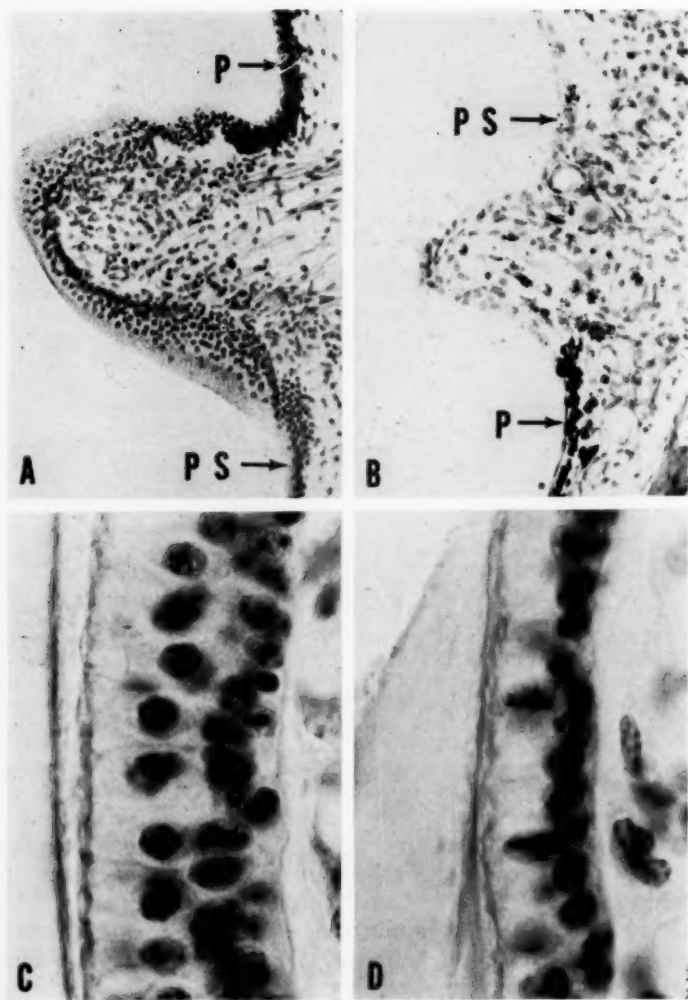


Fig. 7.—Changes in the crista ampullaris. A) Diagonal cut through normal superior canal crista. B) Marked degeneration of corresponding crista affecting the sensory and supporting cells, nerve fibers and the cells of the planum semilunatum (1 month). C) High magnification of normal neuroepithelium of horizontal canal crista. D) Corresponding area showing degeneration of hair cell layer (2 months). P. Pigment cell layer, P.S. Cells of the planum semilunatum.

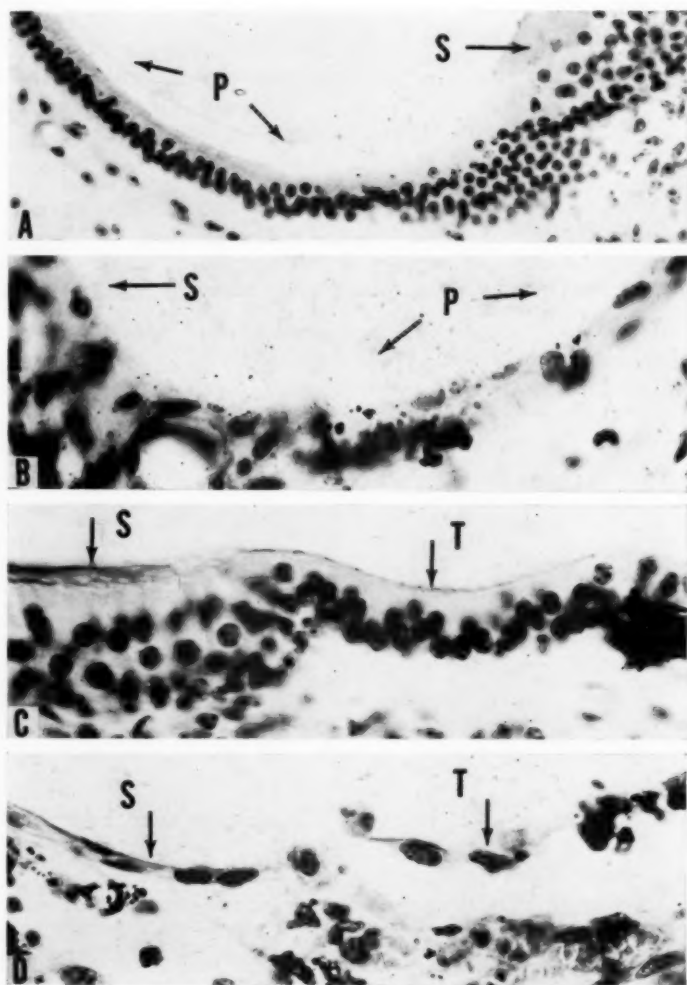


Fig. 8.—A) Side wall of normal ampulla showing cells of planum semilunatum (P) in relation to the sensory cells of the crista (S). B) Similar area showing degeneration of these cells one month after venous obstruction. C) Side of a normal crista showing junction between the sensory cells (S) and the transitional cells (T). The latter are continuous with the cells of the planum semilunatum. D) Corresponding area showing degeneration of these cells.

The perilymphatic hemorrhage slowly disappeared but some blood cells could be seen even after six months.

The wall of the membranous canal was generally resistant to change. Atrophy was noted in a few cases. Many of the epithelial cells in the membranous wall of the common crus contained an excessive amount of fine yellow brown granules similar to those described in the ampullae and utricle. Red blood cells, cellular debris, and phagocytes were rarely seen within the membranous canal.

*Endolymphatic Duct and Sac.* The epithelium of the endolymphatic duct and sac showed very little if any change when compared to the unoperated ear. The sac did not become dilated.

However the contents of the sac often revealed changes. In acute venous obstruction, the duct and sac contained more pink staining proteinous precipitate. Phagocytes containing a greater concentration of yellowish black pigment than in the control ear were easily recognizable and their total number were increased in chronic venous obstruction. These cells were located particularly in the intermediate portion and also in the proximal portion of the sac (Fig. 11).

In some cases hemorrhage into the sac was seen along with hemorrhage in the perisaccular connective tissue. Phagocytes within the sac in these cases sometimes contained red blood cells.

*Scarpa's Ganglion.* Degeneration of Scarpa's ganglion was minimal even when there were extensive lesions of the end organ. The nerve fibers from the cristae and maculae were partly degenerated in severe lesions. The fibers central to the ganglion showed no apparent change.

*Blood Vessels.* The vestibular vein which drains the major part of the vestibular vascular bed was obstructed in different degrees by bone wax and new bone formation (Fig. 12). Despite this many vessels remained open particularly along the endolymphatic sac and internal meatus. Dilation and increase in total number of vessels in the perilymphatic space was often observed. No other collateral vessels from the middle ear or intracranial cavity were demonstrated.

#### COMMENT

The behavior of the animal after obstruction of the inferior cochlear vein and tributaries is indistinguishable from that following acute destruction of one labyrinth. No special manifestations of vestibular dysfunction could be detected.

There is little information about the finer histopathological changes of the vestibular apparatus. The value of human material

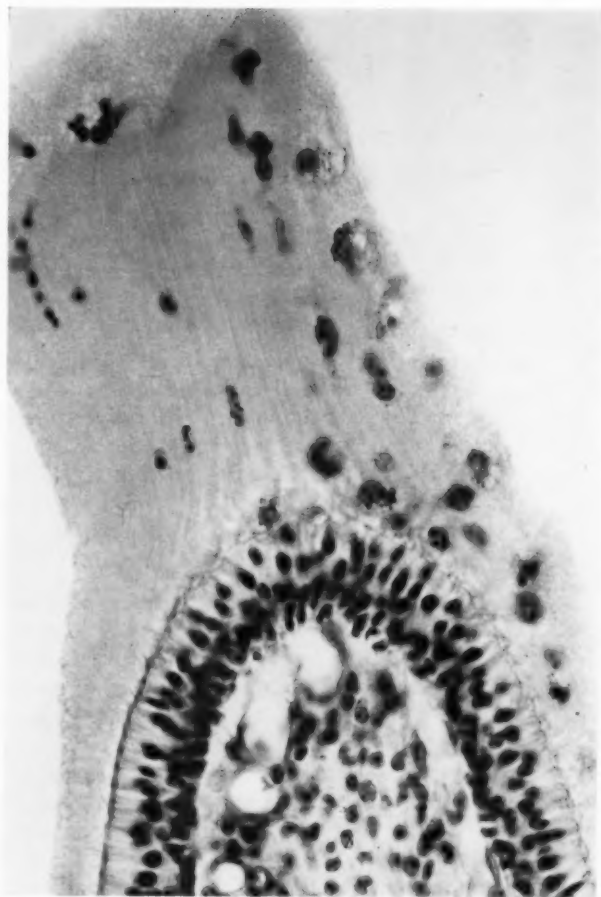


Fig. 9.—Cells containing pigment granules in the cupular substance (after five days).



is limited due to severe postmortem changes. Even experimental material must be carefully controlled to recognize significant changes. For example, decapitation often produces marked swelling of all the sensory cells of the vestibular end organs while intravital perfusion produces the most normal appearance of these cells. Variations in the histologic appearance of the normal labyrinth and organs due to differences in the methods of fixation have been described in detail by Werner.<sup>1</sup> Excepting direct trauma, infection and poisoning (arsacetin see Werner) graded experimental lesions are difficult to produce.

Perhaps the best studied lesions of this type are those due to streptomycin intoxication. This produces definite changes in the vestibular end organs as reported by Causse,<sup>2</sup> Berg,<sup>3</sup> Ruedi,<sup>4</sup> Hawkins and Lurie<sup>5</sup> and others. The hair cells of the cristae and utricle appeared to be particularly sensitive to this poisoning.

Our experiments also indicate the extreme sensitivity of all the hair cells of the labyrinth. In contrast to the findings in streptomycin intoxication, the hair cells of the saccular macula were most commonly damaged following obstruction of the inferior cochlear vein and tributaries. The saccule was as frequently affected as the cochlea. This may be related to the exact distribution of collateral vessels that were obstructed. Other factors that might cause differences in degree of change in the various end organs may be inherent differences in sensitivity and variations in vascular density. The cristae and utricle were less frequently affected. Scarpa's ganglion was less severely degenerated than the spiral ganglion.

Changes in the otolithic membrane and cupular substance are usually difficult to evaluate due to artifacts but in our material the presence of the control ear on the same slide facilitated this evaluation. Disintegration of the hair cell appeared to be responsible for detachment of the otolithic membrane in our experiments. Complete dissolution of the otolithic membrane or cupular substance appeared to be related to the most severe hair cell damage. Berg reported that the otolithic membrane is lost in streptomycin intoxication. In general the otolithic membrane and cupular substance is readily destroyed when the labyrinth is damaged by trauma or infection.

The supporting cells of the maculae and cristae are as resistant to change as the supporting cells of the organ of Corti while at the same time the cells in the subepithelial connective tissue show definite evidence of dissolution resembling that of the spiral ligament. The walls of the membranous labyrinth were generally resistant to change following venous obstruction. Specialized areas of these walls deserve further consideration.



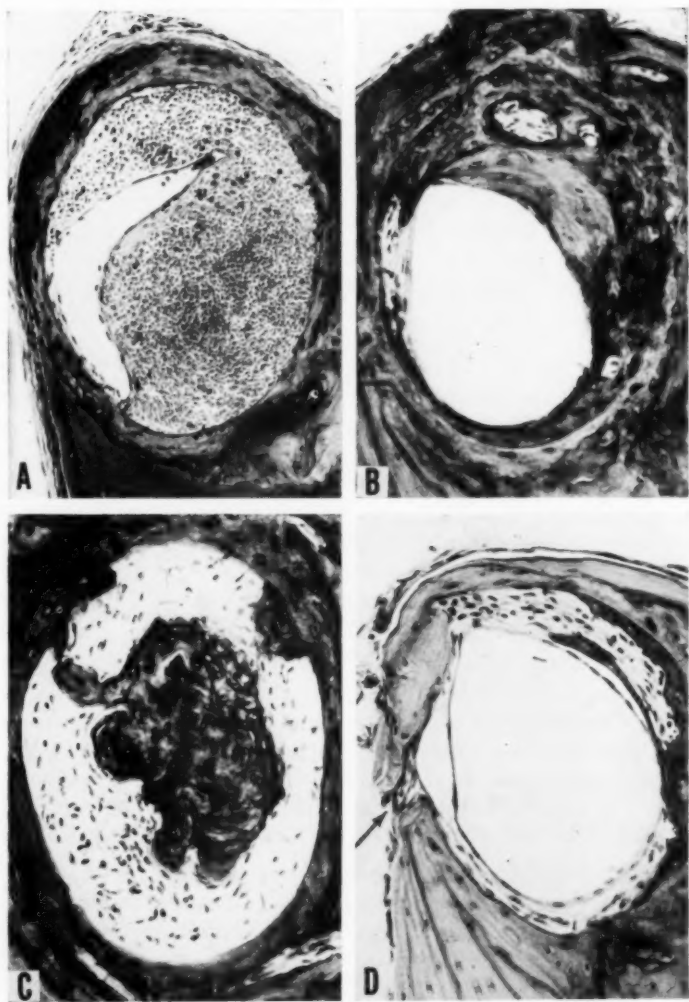


Fig. 10.—A) Severe perilymphatic hemorrhage with compression of the membranous canal (1 day). B) Ossification obliterating the perilymphatic space (5 months). C) Obliteration of perilymphatic and endolymphatic space by bone and connective tissue (3 months). D) Defect in intracranial aspect of bony canal filled with fibrous tissue (arrow). Note also fibrosis and ossification in perilymphatic space (2 months).

The cells of the planum semilunatum at the sides of the crista were generally unaffected except where the crista was severely degenerated. Hypertrophic changes were not seen. The cells of the planum semilunatum have been considered as a source of endolymph, a counterpart to the cells of the stria. However, in this experiment, unlike the stria, the planum semilunatum was very resistant to change. The reason for this difference in sensitivity cannot be clearly ascertained and further clarification of the function of these cells is not possible on the basis of our material.

Some of the epithelial cells of the utricular wall and ampulla normally contain a few intracytoplasmic yellow brown granules. About a month following venous obstruction a marked increase in the number of these granules is clearly evident. The positive reaction to the hemofucsin stain suggests that these granules are related to blood pigments. The reason for their marked increase in number may be related to the hemorrhage produced by this lesion. Both Iwata<sup>6</sup> and Hazama<sup>7</sup> have studied these granule containing cells intensively and have suggested that they have a secretory function. Our experiments indicate that the granules normally present are not necessarily secretory in nature but may be an indication of absorptive activity. These granule containing epithelial cells are particularly evident in albino animals. In the pigmented animals large dark brown pigment cells normally lie adjacent to them.

These pigment cells react strongly in this experimental condition of venous obstruction. There were marked changes in the shape of the cell and evidence of migration into the deeper subepithelial connective tissue and into the endolymph. Disintegration of the cell with release of the large pigment granules was also seen. The function of these pigment cells in the labyrinth is obscure but their observed motility in this experiment suggests phagocytic potentialities. The reaction of these cells resembles that seen in the stria vascularis.

Severe bleeding into the perilymphatic meshwork was a striking reaction to venous obstruction. This is a common result of acute venous obstruction and is probably due to anoxic injury to the vascular wall. The ability of the meshwork to retain the bleeding to the area of the utricle and canals and to prevent its extension into the rest of the perilymphatic cistern was clearly demonstrated.

After a few weeks this blood was partially absorbed and the meshwork cells became more numerous. Proliferation of these cells continued particularly around the membranous canals and was later (one month) associated with ossification. In limited areas all the fluid spaces were obliterated. However, this was compatible with normal sensory cells in the corresponding crista. Absorption of the

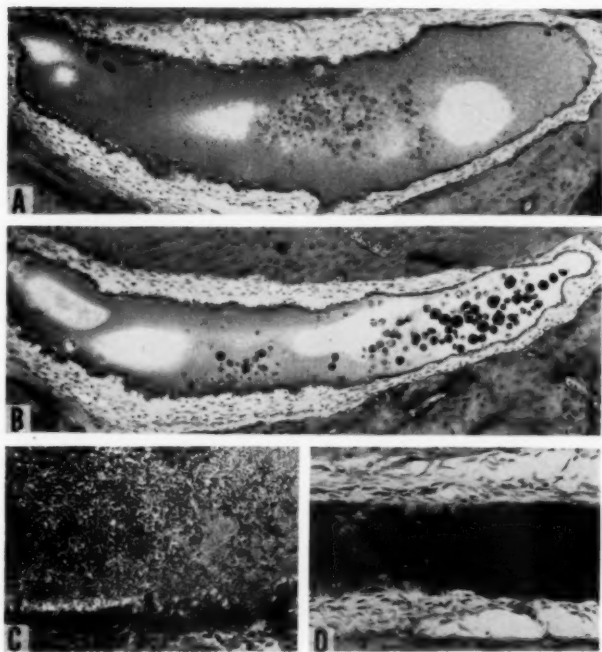


Fig. 11.—Changes in endolymphatic sac. A) Normal control. B) Increase in the pigment within the phagocytes after venous obstruction (5 months). C) Severe hemorrhage in sac (3 days). D) Abnormal fluid contents deep stained with eosin (5 days).

bony capsule in restricted areas around the canal was also noted. The severe hemorrhage resembled that seen in the cochlea.

Unlike the distribution of the perilymphatic hemorrhage in the cochlea which indicated an apical movement, the distribution of blood in the meshwork did not suggest movement in any particular direction.

Furthermore, the blood in the perilymphatic spaces of the cochlea did not induce fibrosis and ossification. There are many stimuli (anoxia, trauma, infection) that are shown to initiate a reaction in the perilymphatic meshwork and other parts of the labyrinth. The factors operating in this experiment that limited the reaction to this area are not clear. Frank hemorrhage into the perilymphatic spaces at the site of fenestration is also followed by a fibrotic reaction in the perilymphatic space according to Shambaugh and Takahara.<sup>8</sup>

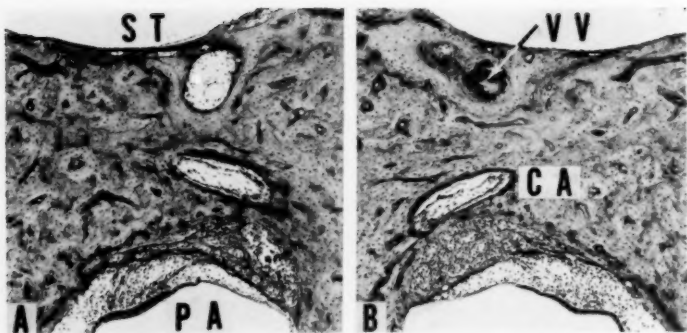


Fig. 12.—A) Section showing normal relations near point of venous obstruction. B) Section through corresponding operated area showing obliterated vestibular vein (V.V.) in relation to the cochlear aqueduct (CA). S.T. Scala tympani. P.A. Posterior ampulla.

There was less bleeding into the endolymph of the utricle, saccule and canals than into the cochlear duct. This is probably due to the differences in arrangement of blood vessels particularly as compared to the stria vascularis. Severe labyrinth bleeding following acute venous obstruction resembles that seen in the human with leukemia. As reported in the cochlea the distribution of blood, pigment granules and cellular debris in both acute and chronic states did not suggest movement of fluid towards the endolymphatic sac. Cellular fragments appeared to be localized to the areas of the maculae and cristae. There was no aggregation of material at the utriculo-endolymphatic valve. As in the cochlear duct blood cells disappeared rapidly from the vestibular endolymphatic space by disintegration and phagocytosis. No consistent change in the size of the vestibular endolymphatic spaces was produced by venous obstruction.

The resistance of all the cells of the endolymphatic sac and duct to this vascular lesion suggests that they have an adequate blood supply from collateral vessels or that they are resistant to stagnant anoxia. Changes in the fluid contents of the sac as well as increased phagocytic activity may be due to local disturbances in function although distant changes cannot be excluded. In only a few cases blood cells within the sac were seen in acute lesions and these were engulfed by the phagocytic cells. This blood was uniformly associated with hemorrhage into the perisaccular connective tissue and did not appear to come from other parts of the labyrinth.

These experiments indicate that, while the inferior cochlear vein carries a large part of the venous blood from the labyrinth, collateral vessels along the endolymphatic sac and into the internal meatus are important. Nevertheless sudden severe obstruction of the inferior cochlear vein even in man might produce severe vestibular symptoms and serious damage to the vestibular apparatus. It is noteworthy that the symptomatology of this partial vestibular lesion could not be differentiated from that of total destruction.

## SUMMARY

Violent vestibular symptoms can be produced by acute obstruction of the inferior cochlear vein and some of its tributaries.

The histological changes in the vestibular apparatus are less severe than those produced in the cochlea. These changes are listed below.

1. The sensory cells of vestibular end organs are particularly affected. The sensory cells of the saccule showed the greatest involvement. The sensory cells in the utricle and cristae were less severely damaged.
2. Marked perilymphatic hemorrhage followed by fibrosis and ossification was produced by this lesion. New bone formation was most frequent in the canals. Even complete occlusion of the endolymphatic space in the superior canal was observed.
3. Detachment and disintegration of the otolithic membrane was observed when there was extensive degeneration of the neuroepithelium.
4. There was evidence of active mobility of the pigment cells as well as disintegration.
5. The epithelial cells along the walls of the utricle and ampullae contained an abnormally large number of yellow brown granules.
6. Other structures of the vestibular apparatus including the cells of the planum semilunatum and of the endolymphatic sac were very resistant to this vascular lesion.

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## LI

### EXPERIMENTAL LARYNGEAL PARALYSIS

RALPH L. GREGG, M.D.

SEATTLE, WASH.

This is a report of the procedure employed and the results from experimentally produced laryngeal paralysis on 22 dogs. Thirty dogs were selected and used for the experiment but the smaller group represents the end result of the types of paralysis for which we were striving. Most of the dogs were operated upon three or four times each, under intravenous nembutal or intraperitoneal morphine, with isolation of the laryngeal nerves on both sides. An electrodyne was used to stimulate the isolated nerves to allow for observation of the action of the muscles in the larynx on the vocal cords. In the production of paralysis some of the nerves were severed, others were either clamped with a hemostat or tied off with suture material.

As previously pointed out by Brien T. King,<sup>1,2</sup> it has been possible to produce any type of laryngeal paralysis by proper selection of nerve branches. In this series the types of paralysis most sought were:

1. Pure bilateral adductor paralysis.
2. Recurrent laryngeal nerve trunk paralysis.
3. Bilateral abductor paralysis.
4. Superior laryngeal motor nerve paralysis.

#### BILATERAL UNCOMPLICATED (PURE) ADDUCTOR PARALYSIS

Dogs No. 2 and 13 illustrate the occurrence of bilateral adductor paralysis. Following surgery in which the adductor branches of the recurrent laryngeal nerves were isolated, stimulated to demonstrate their function and severed, the vocal cords assumed a widely abducted position. The entrance to the larynx was wide open and the dogs had lost all ability to make a sound. Respiration was unaffected. After a lapse of three months Dog No. 2 was reoperated upon and the recurrent nerves were isolated and stimulated. The vocal cords

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From the Department of Physiology, University of Washington School of Medicine, Seattle, Washington.



could not be adducted, even to the slightest degree. Dog No. 13 was reoperated upon two months following the first operation and stimulation of the recurrent nerve trunks caused a little further abduction but the vocal cords could not be moved toward the midline. These dogs had permanent bilateral adductor paralysis.

#### RECURRENT LARYNGEAL NERVE TRUNK PARALYSIS

Strictly recurrent laryngeal nerve trunk paralysis was evaluated in seven dogs with observations extending over a period of several months. In all dogs in which this type of paralysis was produced regardless of the method used there was an absence of bark following surgery. The vocal cords assumed an intermediate position and failed to respond to induced hyperventilation or attempt to bark. There were no deaths immediately following surgery and no apparent increased respiratory effort. One dog recovered the ability to bark four months after the nerve trunks had been crushed with a hemostat. Another dog which had had both recurrent nerves tied off with chromic catgut in August, recovered his bark the following January. Examination of the vocal cords under light intravenous anesthesia revealed full function and free movement of the arytenoid cartilages. A third dog in this group failed to recover the bark from December to the following October after having catgut ties placed on the nerve trunks for one-half hour. Examination after 11 months of paralysis revealed the cords to be well abducted and stimulation failed to cause movement of the arytenoid cartilages or vocal cords. There was no obstruction to respiration. The fourth dog died of suffocation two months following paralysis. Up to this time he had not been able to bark and could take very little exercise. His general health seemed good most of the time. The vocal cords had gradually come closer together until the airway was insufficient to support life. The other three dogs in this group did not recover their bark, were free from dyspnea as long as they did not have to exercise, and maintained good nutrition.

#### BILATERAL ABDUCTOR PARALYSIS

As was anticipated this type of paralysis was hazardous to life and unless steps were taken to furnish an airway the dog was apt to suffocate almost immediately following surgery.

Three of the first four dogs with experimental bilateral abductor paralysis expired from suffocation. After the abductor nerves were isolated and severed the vocal cords immediately came to or near the midline. The first dog died shortly after operation. The second one died on the third postoperative day and the third two weeks following

operation. The fourth one (Dog No. 10) lived for two years before he was retired and placed in a home. He was quite small and did not require much exchange of air. He never regained the ability to abduct the vocal cords. For a long time the vocal cords were quite closely approximated but gradually separated a little to allow for more exchange of air.

#### SUPERIOR LARYNGEAL MOTOR NERVE PARALYSIS

The external and internal branches of the superior laryngeal nerves were isolated on both sides prior to stimulation or injury. Stimulation of one external branch of the superior nerve caused contraction of the cricothyroid muscle on the same side with elevation of the anterior border of the cricoid cartilage and deviation of the cricoid toward the midline. There was no adduction of the vocal cord. A torsion motion was noted when the cricothyroid muscle on one side contracted and moved the anterior part of the cricoid cartilage laterally at the same time it was elevated. When both external branches were stimulated simultaneously, strong contraction of both cricothyroid muscles occurred with elevation of the anterior of the cricoid cartilage without torsion. Some tension was placed on the vocal cords but there was slight, if any, tendency for the cords to be adducted. This was the case whether or not the recurrent nerves were intact.

Destruction of both superior laryngeal nerves resulted in very little detectable motor paralysis of the larynx and no apparent change in bark tone, but sensory changes were noticeable. The mucous membranes of the larynx became edematous and ulcerated within a few days after operation.

Two weeks after removing the superior laryngeal nerves from Dog No. 14 the following observations were made: the edge of each vocal cord was smooth and entirely free of serration or lack of tone; the arytenoid cartilages moved freely on inspiration and with stimulation of the recurrent laryngeal nerves; there was a mild edema of the mucosa of the pharynx and the pyriformis fossa.

#### MIXED TYPES OF PARALYSIS

Seven cases of mixed type of laryngeal paralysis were produced. These included: unilateral abductor with bilateral superior laryngeal nerve trunk paralysis; bilateral recurrent nerve trunk with unilateral superior laryngeal motor nerve paralysis; unilateral abductor paralysis.

An observation worthy of note is that the action of the abductor nerve is much greater when stimulated after it has been severed from

the trunk of the recurrent nerve than before. Also that the abductor nerve is always smaller than the adductor.

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## LII

### HISTORICAL ASPECT OF HEAD AND NECK SURGERY

JOHN J. CONLEY, M.D.

PHILIP H. VONFRAENKEL, M.D.

NEW YORK, N. Y.

The advances in the surgical treatment of cancer of the head and neck in the past fifty years are unique. They represent the crystallization of ideas compounded from the basic operative techniques of pioneer surgeons of the previous centuries.

The development of cancer surgery in the head and neck began with the local excision of the disease by the early Egyptians and in the first century by Celsus who described definite operative techniques for carcinoma of the lip. Progress continued to the comosite resection of the primary cancer and the regional lymphatic area. This concept has continued to progress, not in the expansion of the size of the operation which is now maximum, but in the reparative and reconstructive aspects of the wound. This comprehensive attitude (pertaining to the aggressive excision of the cancerous process and the maximum amount of rehabilitative surgery) imposes the most favorable circumstances to date upon the patient suffering from cancer of the head and neck.

The prime personalities involved in this development actually extend well back into the nineteenth century. There was no single person who had a monopoly in advocating work, but rather a series of investigators who appeared at different decades devoting the bulk of their working energies to the diagnosis and treatment of cancers of the head and neck.

The development of the achromatic microscope in 1824 initiated the precise study of cellular pathology. Virchow, father of cellular pathology, published his study of pathology in 1858 and must be given credit for the first accurate study of tumors. His contribution permitted the objective appraisal of types of treatment and the formulation of reliable inductive cancer statistics.

Pioneer surgeons worked routinely under circumstances that to us seem almost unsurmountable. The medical preparation of the

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From the Head and Neck Department, Pack Medical Group, New York City, N. Y.

patient, the anesthesia, the control of hemorrhage, the maintenance of electrolyte balance, and the prevention of infection added immeasurably to the technical difficulties and hazards of the operation with their unhappy reflections on the postoperative course and cure rate. These serious impediments greatly retarded cancer surgery. This hiatus was finally passed in the fourth decade of the 20th century with the event of the great discoveries in biotherapy, the improved understanding and use of blood transfusions and electrolytes, and the acceptance and development of endotracheal techniques and anesthesiology. These magnificent advances facilitated head and neck surgery to such a degree that even the most formidable procedure could be carried out with security.

In the middle of the 17th century, Pimperlle formally introduced successful surgical procedures on the tongue. Following his death, an interval of almost 200 years passed when practically nothing of significance was contributed to surgery in the head and neck. Then in the early part of the 19th century, C. J. Langenbeck and Mirault caused an interest to develop in intraoral surgery, primarily of the tongue, which has perpetuated. They introduced the wedge-shaped excision and emphasized the value of lingual artery ligation for hemorrhage control. Von Langenbeck later initiated surgical techniques for extension to the lateral pharynx, and utilized mandibular division at the angle for accessibility. In 1831, Jaeger divided the cheek for a facile tongue approach whereas his contemporary, Roux divided the lower lip and jaw in the vertical midline. This contribution by Roux must be considered significant in light of the fact that the mandible and lip-splitting techniques are in active use today and have proved their value in the management of cancer of the alveolus, floor of the mouth, tongue, and lateral neck. In 1838, Regnoli courageously entered the suprahyoid area and carried the dissection up into the floor of the mouth without splitting the mandibular arch. He then pulled the tongue down through this opening in the suprahyoid area so that its diseased portion could be excised. The modern surgeon can well appreciate the technical difficulty of Regnoli's original procedure. Yet his approach must certainly be classified as a so-called "pull through" operation. More than a hundred years later (1950) Ravitch, and later Ward and Robben, popularized a modern type of "pull through" operation for cancer of the tongue with metastasis in the lateral neck. This technique does not disturb the continuity of the mandibular arch.

In 1862, Billroth introduced temporary bilateral mandibular resection for better intra-oral exposure by creating a soft tissue and bone flap at the anterior masseteric borders. He replaced the bony

fragments into their original positions and held them by a wiring procedure. His technique never gained popularity although modifications of this idea appear in the modern literature.

In 1902, Polya published an anatomical study of head and neck lymphatics and showed that in 50 per cent of individuals the normal lymphatics of the floor of the mouth and associated portions of the tongue pass through the periosteum of the mandible to the digastric triangle in the neck. Following this study, there was a greater interest in the en bloc dissection. During the following 50 years interest in mandibular resections increased.

In the 18th century, Le Dran believed that cancer was local in its early stages and that it spread via the lymphatics to the local nodes and then throughout the body. He removed the nodes but viewed this phase with pessimism.

Until 1875 there had been very little emphasis directed toward the treatment of lymph nodes in the neck. In this year, Baron von Langenbeck described an operation dividing the mandible and soft tissues in order to gain access into the mouth "for the purpose of removing the tongue, gland, and part of the palatine arches and tonsils." Within five years, Kocher introduced a procedure to gain entrance into the oral cavity by performing an osteotomy behind and below the angle of the jaw. Through this approach, he described and advocated a technique for the removal of the base of the tongue, floor of the mouth, and lymphatic glands situated in that region. To these surgeons goes the very significant credit for the conception of not only the treatment of the primary cancer but also its metastatic deposits in the regional lymphatic drainage bed. Their emphasis on the treatment of the lymph nodes may also be considered the precursor to the so-called elective or prophylactic neck dissection. This concept has become fundamental in the modern management of cancer of the head and neck. It is the comprehensive application of this principle of dissection in continuity which has accounted in great part for the advancement and success in the treatment of advanced cancers of the head and neck system.

It must be said that the phase of more ambitious surgery was preceded by two monumental events. In 1842, Long first administered ether for the removal of a neck tumor. The general use of this agent was widely acclaimed four years later and the word "anesthesia" was coined by Oliver Wendell Holmes. In 1867, Lister, stimulated by Pasteur's observations that living germs were everywhere, enunciated the principle of antiseptic surgical technique. Listerian methods were clinically applied by VonLangenbeck, Von Bergmann and

especially by Mikulicz in Billroth's clinic. He is credited with the use of iodoform gauze in the head and neck orifices.

In 1885, Henry T. Butlin made a profound study of diseases of the tongue. He advised concerning the management of premalignant lesions in the mouth. He emphasized the value of early diagnosis and aggressive adequate treatment. He classified the various types of subtotal lingual techniques, recommended the removal of the lower portion of the parotid gland because it contained lymph nodes, and devised appropriate neck flaps for adequate exposure of the neck contents. His procedure exposed the internal jugular vein and carotid artery and included the removal of the gross lymph nodes in the neck along with the submaxillary gland and platysma muscle. Sir Henry Butlin was one of the leaders of his day and was also consulted by such greats as Sir St. Clair Thompson on laryngeal problems.

Up to 1906, practically all of the important work in the treatment of cancer of the head and neck had been carried out in Europe. In this year, George Crile published his experience in the treatment of cancers in the head and neck. He was considered the primary proponent of this type of surgery in the United States. He devised appropriate neck flaps for the adequate exposure of the neck contents and his original surgical techniques were developed over a period of the following 15 years into what is basically considered today to be the radical neck operation. His operative mortality in simple neck dissections was in the neighborhood of 13 per cent. He applied the philosophy of the composite resection of the primary cancer and the lymphatic drainage bed to the tongue, cheek, alveolus, and lip with considerable success. He employed a pneumatic suit to support circulation during the operation and devised a carotid artery clamp to conserve blood loss and apply gradual compression of the carotid vessel. Epically, one of the most significant features of his techniques pertained to the method of anesthesia which was carried out by double nasal tubes down the epiglottis with tamponing above the tube to prevent aspiration of blood and dilution of the anesthetic agent. It is interesting commentary that F. W. Hitchings reviewed 4500 cases of cancer of the head and neck for Crile and reported less than 1 per cent with visceral metastasis. Armed with this research, the results of which were obviously in error, he formulated his attack on cancer of the head and neck and popularized it in the United States. Sugarbaker (1940) reported a more reasonable 18 per cent with visceral metastasis.

In 1927, Semken accurately described and advocated radical neck dissection when the majority of the outstanding oncologists in the country were preoccupied with irradiation. In 1932, he reported



a method of block dissection in which cancer of the mouth was removed with the related neck lymphatics.

In London, in 1931, Spencer and Cade completed the third edition of Butlin and Spencer's 1900 second edition. They altered the lateral neck excision, clarified the criteria for the lateral neck dissection, and advised that recurrent metastasis in the neck be either reoperated in selected cases or treated by irradiation.

In 1932, Ward performed a composite operation consisting of a subtotal excision of a portion of the tongue, floor of the mouth, and mandible in continuity with a radical neck dissection.

In an analysis of the balance of forces which either stimulated or retarded the development of radical surgery in the oral cavity and neck, one must consider the impact that irradiation had on the treatment of malignant tumors in these areas. The enthusiasm of many of the leading oncologists for irradiation in the treatment of these malignant tumors was sustained until the early 1940's. Shortly before this, the undesirable late effects of intensive irradiation became manifest. Re-evaluation of the therapeutic value of irradiation was disappointing in respect to treatment of certain tumors in the head and neck. Major surgical procedures were being carried out with ever increasing security. In the past 15 years in the United States, well standardized surgical techniques have replaced irradiation as a primary method of treatment in the vast majority of surgically accessible lesions. This trend is being followed at a slower rate throughout the world.

In 1941, Blair, Moore, and Byars published a book on cancers of the face and mouth which was an analysis of the treatment of extensive cancerous processes of these sites by sharp and electrocautery excision. They demonstrated the practicality of bilateral neck dissection done in two sittings. One of their most significant contributions was the use of massive tissue flaps in the reconstruction of the large wounds created by the excision of the extensive cancerous processes.

In 1944, Brown and McDowell developed a technique for radical neck dissection which recommended the resection of the tendons of the hyoid bone to gain improved accessibility to the upper ends of the internal jugular vein. They later learned that Ducuing, Fabre and Gouzy had described a similar technique in the French literature. Brown and McDowell also advocated preserving the spinal accessory nerve whenever possible and the resection of the platysma muscle with the specimen. They decried the use of the misleading term "prophylactic" neck dissections, but were early proponents of neck dis-

section for probable small metastasis as an elective procedure. This idea has gained many adherents in the treatment of certain lesions of the head and neck.

In 1950, Ward and Hendrick published a book on Cancer of the Head and Neck. Their work is the most complete and modern text in this field. It deals comprehensively with the various aspects of this disease and deserves a place in the library of everyone interested in this disease.

In 1951, Martin, who had been one of the most active workers in irradiation and surgery in the field of cancer of the head and neck, during the previous thirty years, published a review of 1450 cases of neck dissection. This report is a classic and milestone in the excisional aspects of this work. Martin is a proponent of radical surgery over irradiation for the treatment of cervical metastasis. He does not advocate the so-called "prophylactic" or elective neck dissection. He favors complete neck dissection rather than partial dissection. He has observed and reported on the treatment of cancers in various sites of the head and neck system and statistical analysis for the past twenty years, and his studies are fundamental and important. In 1934, Martin and Ellis popularized aspiration biopsy as a diagnostic aid. This vital but heretofore neglected procedure had been proposed by Nicholas Senn, pioneer cancer surgeon, at the turn of the century.

Conley and Pack (1952) extended the principles of vascular surgery to the neck in the treatment of certain types of metastatic fixity to the carotid structures, carotid body tumors, and threatened hemorrhage of the carotid arteries.

The treatment of laryngeal tumors was of interest to doctors for ages, but very little organized surgery existed prior to the 19th century. In 1812, Desault suggested an operation of splitting the larynx to remove trapped foreign bodies. This idea was later used to gain access to laryngeal tumors. Gurdon Buck of New York was the first to perform the operation of laryngofissure to remove a malignant growth in 1851. It was not until seven years after Garcia introduced the laryngeal mirror (1854) that the value of indirect laryngoscopy was appreciated and the groundwork for organized laryngeal surgery was prepared. The first use of this instrument was by VonBruns who removed a large polyp from the vocal cord in 1861. The results for the removal of intralaryngeal malignant tumors was most unsatisfactory and VonBruns reported a one year survival rate of two out of nineteen cases.

The laryngofissure operation for removal of laryngeal malignancy remained unpopular until under the preceptorship of Butlin, the

eminent surgeon, and Semon, the astute diagnostician, the technique and applications of this surgical procedure became well defined. Other pioneers followed until the operation reached the summit of utility under Sir St. Clair Thomson in England and Chevalier Jackson in the United States. They and their preceptors taught that the greatest efficacy followed the proper indications for this operation. An intrinsic, unilateral, moderate sized lesion offered the best possible cure.

Professor Billroth of Vienna performed the first total successful extirpation of the larynx in 1873. The wound had been left open and the patient died of recurrence in seven months, but the preliminary steps had been worked out. As most of Billroth's cases were of the extrinsic variety, recurrences were frequent. Of his first 25 cases operated on prior to 1890, not one was alive at the end of the year. Baron Von Langenbeck reported on total extirpation of the larynx in 1875. His series were similarly dismal. The high mortality and the gloomy curative rate during this period caused the famed Sir Henry Butlin to say in 1887 that he wondered as to whether cancer surgery in this area was ever justified. Mortality from complete laryngectomy was almost as bad as the disease itself.

In 1887, the most famous of all laryngeal cases concerned the German Crown Prince later to become Emperor Frederick III. Afflicted with the disease, he was seen by Morell Mackenzie, one of the most famous laryngeal authorities of his day and who wrote "Diseases of the Larynx, Pharynx and Trachea." Mackenzie took several biopsies from his royal patient and the tissue was studied by the celebrated pathologist, Virchow. For a long period, the tissue showed no evidence of malignancy. The German medical authorities wished to do a laryngectomy, but Mackenzie was reluctant to operate in view of a negative biopsy and the high mortality. The Emperor ruled three months and succumbed to his disease. He was succeeded by his militaristic brother, William II, whose aggressive policies culminated in World War I, which disturbed world equilibrium to the present. It is fascinating to speculate what may have happened had Mackenzie obtained the right biopsy site at the early phase of the disease. Perhaps Mackenzie may have been influenced to perform a laryngectomy on clinical appearance alone had Solis Cohen developed the technique of creating an improved tracheal stoma by severing the trachea (1891) some years earlier.

The idea of an improved tracheostome with primary repair of the pharynx and extirpation of the larynx, pharynx and esophagus was further advanced by Gluck and Soerensen in 1913. They developed the idea of separation of the larynx from above which was



1. KOCHER 1880



2. BUTLIN 1885



3. CRILE 1906



4. SPENCER-CADE 1931



5. DE QUERVAIN



6. KUETTNER



7. MARTIN 1940



8. CONLEY 1946

NECK INCISIONS

popularized in the United States by Babcock in 1931 who collaborated extensively with Chevalier Jackson on this problem. Later, Clerf used this method of laryngectomy exclusively in his clinic. He felt this approach was superior to dissection from below in that sepsis was avoided by closing the pharyngeal defect first and aspiration of blood and secretions was avoided by separating the trachea at the close of the procedure.

One might classify the ingenious laryngopharyngeal operations of Gluck and Soerensen as the forerunner of the aggressive plastic procedures that developed over the next 42 years and which culminated in the one stage excisional-reconstructive procedures such as described by Negus, Edgerton and Conley.

The differences between intrinsic and extrinsic lesions were being noted by clinicians. As early as 1879, Krishhaber made the observation which is still valid that cancer arising in the interior of the larynx was extremely slow in development and remained well-defined for quite a long period whereas cancer of the extrinsic larynx was insidiously rapid. Thomson appreciated this far reaching observation and emphasized that it was necessary to classify intrinsic and extrinsic lesions of the larynx. The classification of extrinsic lesions was as varied in Thomson's day as it is at present. Thomson emphasized the ruthlessness of the extrinsic forms and the subglottic extension of the intrinsic variety of laryngeal carcinoma. He recommended laryngectomy for cordal fixation and if the disease extended too far anteriorly, posteriorly, or below the cricoid cartilage.

The same year that Thomson proposed his classification which is still in use today, MacKenty (1922) reported on 31 laryngectomies for intrinsic cancer of the larynx without a death following surgery. He was a persistent and energetic investigator in this field, contributing classical studies to the understanding of carcinoma of the larynx and techniques for total laryngectomy. His overall results compare favorably with the workers in the field today.

In 1928, New described a two-stage laryngectomy operation and a few years later, Portmann advocated creating a pharyngostome which was to be closed by a subsequent plastic procedure. These techniques have never been accepted for uncomplicated cases although at their innovation the problem of infection was a vital one.

In 1938, Crowe and Broyles designed a more stable closure of the pharyngeal operative defect by utilizing the sternohyoid muscle over a crescent shaped repair of the pharyngeal mucosa. The latter in 1943 published his work on the anterior commissure tendon of the vocal cord and the importance of this area in metastasis.

Chevalier Jackson in 1940 popularized and stressed the narrow field laryngectomy for intrinsic lesions. This was an important contribution prior to the use of antibiotics for it decreased the previous postoperative fascial plane infections.

In 1944, an innovation in simplified technique was suggested by Vasconcelos and Barretto. Using a special clamp, they resected the larynx from the pharynx without opening the pharynx. This clamp was useful in the pre-antibiotic days but did not allow lesion visualization.

The problem of conservation of laryngeal function has always interested Europeans and South Americans more than their contemporaries in this country. Conservation of laryngeal function may have a definite place in laryngeal surgery for those individuals who will not emotionally accept the complete laryngectomy. It is of interest, therefore, to note that the greatest emphasis on this phase has been in the Latin countries.

The technique of hemilaryngectomy was used on occasion by Gluck in Germany, highly popularized in France by Portmann, but never quite accepted in the United States. The danger of this operation lay in the difficulty of guarding the respiratory tract from blood and mucus and required a longer period of convalescence.

Wilfred Trotter in England attempted conservation of function in extrinsic tumors of the larynx and especially the hypopharynx. He resected the lesion and repaired the defect with a pedicled flap from the anterior neck. He skillfully utilized a lateral pharyngotomy approach. Most of his extrinsic lesion cases died of recurrence. Orton, in the United States, further modified Trotter's technique.

In 1951, Alonso of Uruguay, published his "Conservation of Function in Surgery of Cancer of the Larynx" in which he proposed extirpation of small pyriform sinus, epiglottic and subglottic tumors without sacrificing the cords. He devised a partial vertical laryngectomy for pyriform sinus tumors and a partial horizontal laryngectomy for epiglottic tumors.

The pendulum in the United States still swings toward more aggressive surgery. Ogura and others proposed that elective neck dissection and laryngectomy be done in supraglottic lesions.

The immediate future of head and neck surgery will doubtlessly see the maintenance of aggressive adequate surgery, at least in the United States, compensated by the greater use of plastic and reconstructive procedures. The development of various prosthetic aids and materials for use as implants is permitting better restoration of

function after the radical procedure. One cannot help but be impressed by the cumulative effort exerted by those interested in the problems of head and neck surgery over the past years and the knowledge that this advance is still continuing.

This technical progress must be balanced by a full respect for the patient's capacity to survive and function as a human being. Excisional surgery has reached proportions that could, if not applied with high moral feeling, defeat the very reasons for its use. This eagerness in surgery must reflect itself not only in the statistical data of life and death, but in the functional aspects of living itself and all that it means to the patient.

139 EAST 36TH STREET

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LIII

THE EFFECTS OF PRESSURE IN THE  
EXTERNAL AUDITORY MEATUS

WALTER E. RAHM, JR., M.D.

WILLIAM F. STROTHER, M.D.

AND

JESSE F. CRUMP, M.D.

PRINCETON, N. J.

As the atmospheric pressure is changed a feeling of pressure in the ear is a common experience. Variations of altitude, as in aerial flight, mountain climbing, or riding in fast elevators, produce such changes. Ordinarily the eustachian tube permits an equalization of the pressure between the middle ear cavity and the outside world. But if the eustachian tube is blocked through congestion in the nasopharynx, or growths in this region, pressure differences can become acutely painful and cause a deformation of the drum membrane great enough to rupture it. Temporary or permanent impairments of hearing may result from altered pressure in the ear, thus making the matter of pressure changes clinically important. This problem necessitates an understanding of the effects of pressure on the normal ear.

Experimentally there are two ways of introducing pressures into the ear, and in each of these the pressure difference may be either positive or negative. One of these methods is to introduce the changes into the middle ear cavity as done by Fowler,<sup>3</sup> Thompson, Howe, and Hughson,<sup>10</sup> Kobrak,<sup>5</sup> Loch,<sup>6,7</sup> and Wever, Bray, and Lawrence.<sup>11</sup> Another way of producing pressure changes is by means of the external auditory meatus as indicated by Mach and Kessel,<sup>8</sup> who, using themselves as subjects, introduced positive pressures up to 14 cm of water (5.5 inches of water) into the external auditory meatus and observed a general weakening of the loudness of tones. Low tones were more affected than high tones.

Békésy<sup>1</sup> found that positive and negative pressures of 10 cm of water (3.9 inches of water) applied at the external auditory meatus

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reduced the loudness of low tones, up to 1000 or 1800 cycles. For a small frequency region around 1800 cycles he found an increase in loudness. Higher tones showed slight or irregular effects.

Van Dishoeck and DeWit<sup>2</sup> studied the effects of pressure on normal and defective ears and determined in each the pressure value that gave optimum sensitivity. In most cases this value was zero, but they found normal ears to be best at a slight negative pressure, usually in the range up to  $-4$  cm of water ( $-1.6$  inches of water). For persons suffering from nasopharyngeal congestions the best hearing was nearly always at negative pressures, mostly around  $-10$  but as high as  $-40$  cm of water ( $-3.9$  and  $-15.7$  inches of water).

Rasmussen,<sup>3</sup> using tones from 64 to 11,600 cycles, extended these observations and obtained similar results. It is important to note that he reported the use of pressures up to the equivalent of 40.2 inches of water.

Hansen,<sup>4</sup> using tones from 100 to 8000 cycles and with pressures in the external auditory meatus from  $+20$  to  $-20$  cm of water ( $+7.8$  and  $-7.8$  inches of water) studied the effects of static air pressure on threshold sensitivity, hearing acuity, and speech intelligibility.

It should be remembered that pressure introduced into the external auditory meatus, though similar, is not exactly comparable to pressure introduced into the middle ear cavity. With pressure in the external meatus the drum membrane and round window membrane displacements are in the same direction. With pressure introduced into the middle ear the drum membrane and round window membrane displacements are in opposite directions.

In the present experiment the problem of pressure in the external auditory meatus was investigated with cats as experimental animals, and the cochlear potentials were employed as an index of auditory action.

#### PROCEDURE

The middle ear was approached laterally by a triangular skin incision, division of the external carotid artery, removal of the parotid gland, resection of the digastric and stylohyoid muscles, and removal of the periosteum from the surface of the bulla. Two holes were drilled in the bulla. One, about 2 mm in diameter, was located laterally near the jugular process of the occipital bone. The other, about 5 mm in diameter, was placed on the mesial side of the bulla at the same level as the first along the sagittal axis. The larger opening provided a view of the round window niche and a portion of its membrane, and made possible the placement of an electrode through the smaller hole onto the membrane.

Both holes were carefully reamed and fitted with rubber stoppers; the electrode wire passed through the smaller stopper, and carried a piece of platinum foil on its end. The lengths of wire and foil were adjusted so that on insertion of the stopper in the opening the tip of the foil made contact with the surface of the round window membrane. Experience proved that a change in the pressure on the drum membrane can alter the volume of air in the middle ear cavity by forcing air into and out of the eustachian tube. Therefore the eustachian tube was kept closed by pressing on it from below with a spatulate rod. Also a rubber stopper pierced by a short piece of metal tubing was inserted in the larger hole in the bulla, and a short length of plastic tubing was attached. This tubing was kept clamped during the readings, but was unclamped for a moment and reclamped after each pressure run. It was essential to use a method of clamping that did not alter the air pressure in the bulla cavity.

Positive pressure was introduced by a rubber bulb, and indicated by a pressure gauge. This gauge was calibrated from 0 to 24 inches of water both for positive and negative pressures. Negative pressure was produced by a 50 cc syringe. The animals were maintained under deep anesthesia with diallyl-barbituric acid and ethyl carbamate, with a dosage of 1 cc (each cc contains 0.1 grams of diallyl-barbituric acid and 0.4 grams of ethyl carbamate, "urethane") per kilogram of body weight injected intraperitoneally. A constant physiological preparation was obtained by the use of a tracheal cannula inserted immediately after a surgical level of anesthesia was reached. Throughout the experiment the cochlear response remained constant within less than 2 db for zero pressure.

Tonal stimuli were generated by a General Radio Type 913-C beat frequency oscillator whose output was connected to a Davenport T-693 attenuator with a range from 0 to 111 db. The output from the attenuator was fed into a specially designed crystal transducer, whose output was connected by a rubber tube directly into the external auditory meatus of one ear, after removal of the pinna. With this arrangement the transducer was exposed to the changes of air pressure but the design was such that these changes had no appreciable effect upon the output of sound.

Cochlear potentials picked up from the round window were amplified and measured with a General Radio Type 736-A wave analyzer operated as a voltmeter.

The intensity of each tone was adjusted initially to give a response of 50 microvolts for zero value of pressure. Some value of positive or negative pressure was then applied, and the altered magnitude of

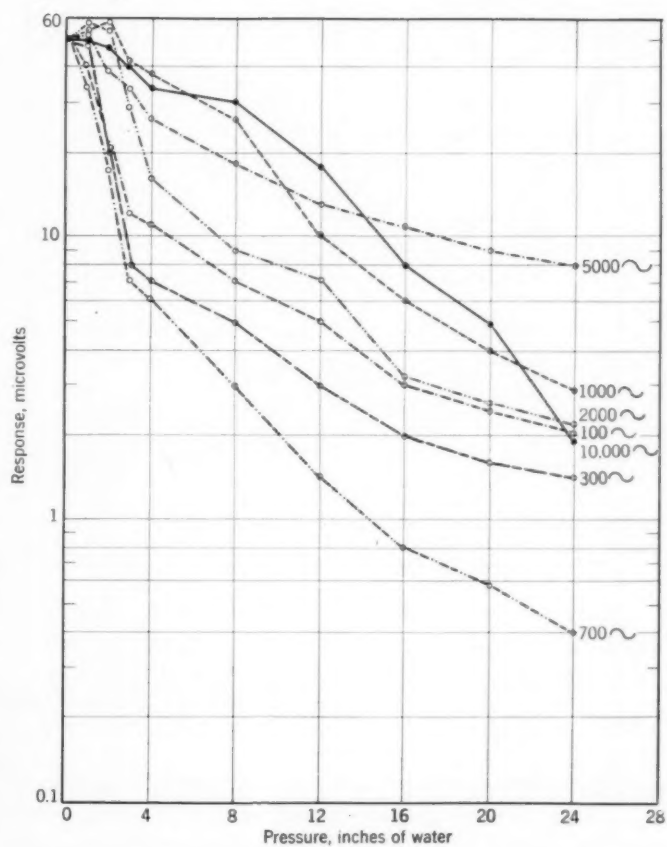


Fig. 1.—The effects of positive pressure upon the cochlear potential response for various frequencies.

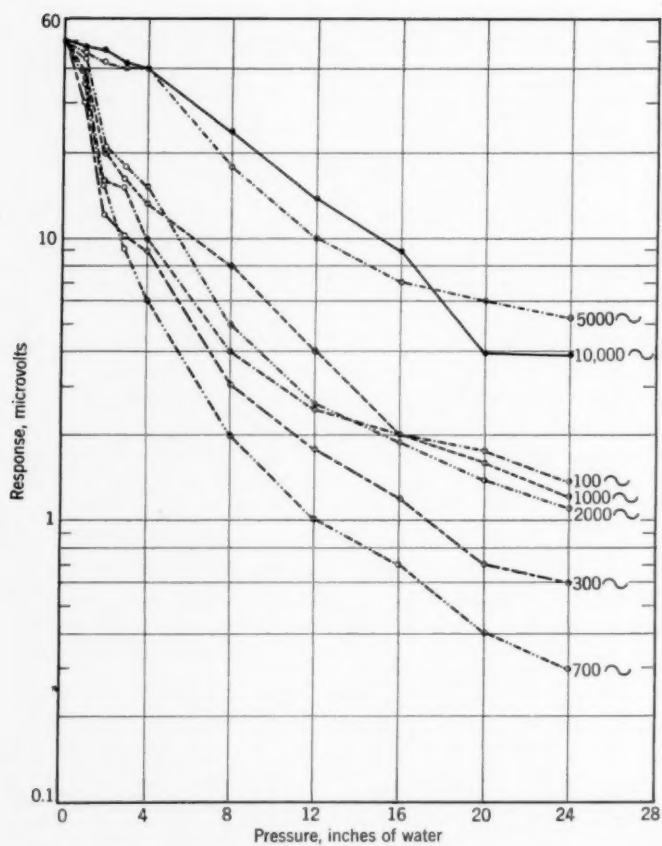


Fig. 2.—The effects of negative pressure upon the cochlear potential response for various frequencies.



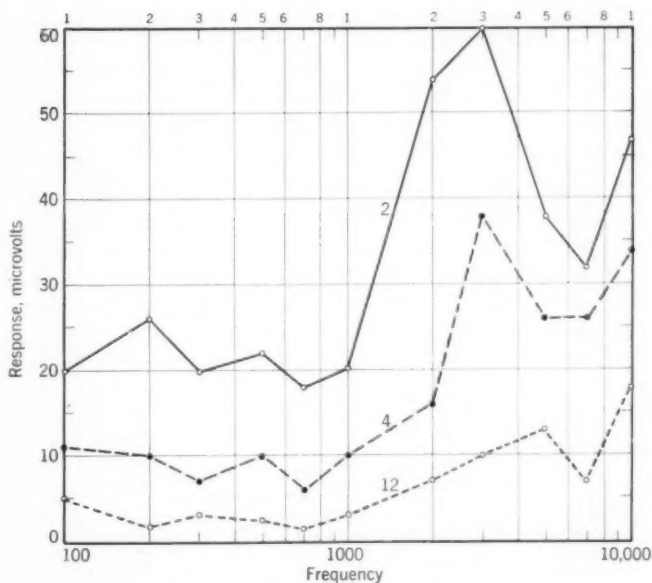


Fig. 3.—The effect of certain positive pressures upon the cochlear potentials as compared with a potential of 50 microvolts at zero pressure. Pressure in inches of water is indicated above each line in the graph.

the cochlear response was observed. The experiments were carried out on 27 animals. The animal in each case was isolated in an electrically shielded sound-proof room.

#### RESULTS

In general, as shown in Figures 1 and 2, a decrease in cochlear response was concomitant with a change in pressure for all frequencies. For the low tones (below 1000 cycles) at a positive or negative pressure of 4 inches of water the drop in cochlear response amounted to 18 db or more. For the high tones at the same pressure the loss varied from 2 to 7 db. At 24 inches of water the loss in response for 700 cycles was 42 db and for 5000 cycles was 14 db.

It should be mentioned here that after any change of pressure a period of adjustment followed before the response reached a stable value, as was previously observed by Wever, Bray, and Lawrence.<sup>11</sup> In this experiment care was taken to allow sufficient time for stabilization after any alteration of pressure.

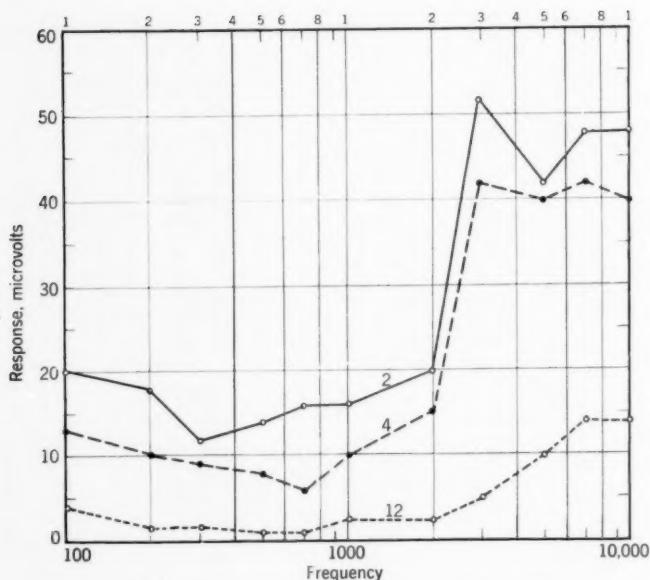


Fig. 4.—The effect of certain negative pressures upon the cochlear potentials as compared with a potential of 50 microvolts at zero pressure. Pressure in inches of water is indicated above each line in the graph.

The fragility of the drum membrane is indicated by the fact that in some of the animals it ruptured at the first application of a pressure of 24 inches of water. This failure occurred in 5 out of 27 or 18 per cent of the animals used. Wever, Bray, and Lawrence<sup>11</sup> in a previous paper found a failure of 16 per cent of drums subjected to a similar amount of pressure. In examining the perforated drums it was observed that all were opaque and milky in color.

The relation of frequency to the sensitivity function of the ear is best shown in a different form of plot, that of Figures 3 and 4. The different curves represent different conditions of positive or negative pressure as given in inches of water, indicated by the number above each curve.

The drop from the base line of 50 microvolts is greatest for the low tones. An enhancement of response was obtained for low values of pressure at certain of the medium high frequencies. Figure 3 shows this effect at 2000 and 3000 cycles for a positive pressure of 2 inches of water. This improvement however never exceeded 2 db.

## COMMENT

These results on the effects of pressure in the external meatus are closely similar to those obtained by the introduction of pressure in the middle ear cavity. A comparison of the results given here and those obtained by Wever, Bray, and Lawrence for alterations of pressure in the cat's middle ear shows that the functions are of the same form and also are comparable in the absolute amounts of change.

It seems likely that the effects of positive and negative pressure on sound transmission are due primarily to an alteration in the tension of the drum membrane. This conclusion was reached by Wever, Bray, and Lawrence on the basis of the study first referred to, and is further supported by the present results. This theory supposes that the drum membrane under increasing pressure assumes more and more the character of a stiffness-controlled membrane.

Békésy<sup>1</sup> concluded on the basis of his experiment on the effects of pressure in the external meatus of human subjects that for frequencies up to 1000 or 1800 cycles the drum membrane operates as a simple membrane, but for higher frequencies its different regions vibrate out of phase so that effectively it breaks up into concentric rings. Our evidence indicates that this transition to a more complex mode of movement occurs at progressively higher frequencies as the membrane is stiffened by the application of pressures.

## SUMMARY

An increase in pressure in the external meatus has a marked effect upon the electrical responses of the cochlea. For certain tones a small degree of pressure produces a slight improvement, but large pressures always cause a reduction of the responses. Generally speaking, low tones are more affected than high tones, but the relation is not exactly in the order of frequency.

The principal effects are upon the drum membrane and are attributed to changes in its tension.

PRINCETON UNIVERSITY

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## LIV

### DYSPHONIA PLICA VENTRICULARIS

#### AN OVERLOOKED CONDITION CAUSING

#### CHRONIC HOARSENESS

WILLIAM H. SAUNDERS, M.D.

COLUMBUS, O.

Dysphonia plica ventricularis was first described by Jackson and Jackson in 1935.<sup>1</sup> Previous authors had described vocal states probably resulting from this condition, but they failed to correlate voice changes with laryngeal appearances. Since 1935 no additional articles written by physicians describing this condition have appeared in the literature. I find that some otolaryngologists are unaware of this relatively common cause of hoarseness.

Dysphonia plica ventricularis is easily overlooked for two reasons. First, it often occurs in a larynx which is otherwise relatively normal. Patients who are hoarse because of other conditions are usually hoarse because of a change in the mucosa of the vocal cord (neoplasm, infection, or trauma), or as a result of a paralytic condition or feebleness of the laryngeal musculature. As otolaryngologists, we look carefully for changes in the configuration and color of the laryngeal mucosa, and we are quick to note variations in the movement of the true cords. On the other hand, we may fail to appreciate minor changes in the appearance and function of the false cords.

Second, dysphonia plica ventricularis is also easily overlooked because it is inconstant. It may be present during one laryngeal examination and not during another. A transient functional alteration in the larynx such as this may go unrecognized unless one keeps the condition in mind.

#### INCIDENCE

Significant statistics are not available for comparing the incidence of dysphonia plica ventricularis with other causes of chronic hoarseness. However, 20 patients with dysphonia plica ventricularis complaining of hoarseness have been seen in the otolaryngological clinic of the Ohio State University Medical Center during the last year. In

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From the Department of Otolaryngology, The Ohio State University.

mild or transient form, the condition is much more common than that. There have been fewer than 20 cases a year of laryngeal carcinoma, vocal nodules, hysterical aphonia, contact ulcers, or cricoarytenoid ankylosis.

Jackson and Jackson, reporting from a clinic with a high incidence of organic disease, gave the incidence as 4 per cent. Most private practitioners might expect a higher incidence of dysphonia plica ventricularis among their chronically hoarse patients.

Voelker<sup>2</sup> studied 2000 college men and reported an incidence of 6 per cent for dysphonia plica ventricularis in the general population. Of this group of 2000, 1.2 per cent were markedly hoarse and 4.8 per cent intermittently hoarse. Voelker assigns an incidence of 16 per cent to dysphonia plica ventricularis when compared to all causes of acute phonopathy.

#### THE SYMPTOMS

Patients with dysphonia plica ventricularis complain of a hoarseness which varies in severity. Some of the patients are hoarse all of the time, but many are not. Sometimes the voices of these patients are good in the morning but deteriorate as the day wears on. There is often an uncertainty of tone which produces a result like the breaking voice of an adolescent male. Occasionally, for a few moments, the patient may almost lose his voice. Some patients complain of a tiredness in the throat, particularly in the evening. Others may make persistent attempts to clear the throat, but they raise neither mucous or pus. Dyspnoea is not a symptom, and the patient does not have stridor.

According to Voelker oscillographic studies of the voices of persons with dysphonia plica ventricularis indicate pitches in the order of 50 to 60 cycles which he says places the key in between the natural voice and that of the laryngectomized patient producing esophageal speech.

The condition is likely to disappear spontaneously and to reappear months later, particularly if the patient is subjected to a situation involving psychologic stress. Other patients continually have dysphonia, which varies only in degree.

#### LARYNGEAL APPEARANCES

Indirect laryngoscopy is usually sufficient for diagnosis. Direct laryngoscopy may be required if it is necessary to look into the ventricle, to look directly beneath the true cords, or to test the mobility of the cricoarytenoid joint.



Fig. 1.—Normal larynx, quiet respiration. Identical picture may be present in dysphonia plica ventricularis of recent origin.



Fig. 2.—Dysphonia plica ventricularis, quiet respiration. Note prominence of ventricular bands.



During quiet inspiration, the larynx may look normal (Fig. 1). Jackson and Jackson said that the false cords often look thickened or hypertrophic (Fig. 2). While their observation is true of long standing cases, it is not true of the patient with dysphonia plica ventricularis who has become hoarse recently. In such a larynx the false cords may look entirely normal during quiet breathing.

When the patient is asked to phonate, several different laryngeal appearances may be seen in the mirror:

- 1) The patient, approximating only the true cords, may phonate normally. There is a normal voice for that period of the examination.
- 2) The true cords may approximate producing a clear tone initially, but almost immediately the false cords close above the true cords and seem to vibrate. The tone is altered for the worse.
- 3) The false cords may close completely and tightly, usually only momentarily, and so render the patient aphonic (Fig. 3).
- 4) The false cords may close ahead of the true cords. One wonders if the true cords are functioning at all, since the examiner is not able to see under the false cords.
- 5) The false cords close irregularly and leave one or more small gaps through which portions of the true cords can be seen (Fig. 4).

A single patient may demonstrate more than one laryngeal appearance during an examination. It is important to realize that a prolonged examination may be required for diagnosis because some patients with dysphonia plica ventricularis phonate normally part of the time.

The question arises as to how the false cords manage to close at all. They have only minimal muscular fibers (Fig. 5), yet in dysphonia plica ventricularis they are seen to close across the top of the true cords with no difficulty. The closure of the false cords may appear almost as accurate and brisk as the normal closure of the true cords.

When the larynx acts as a complete sphincter, the aryepiglottic folds and epiglottis are squeezed together and one can imagine a simultaneous carrying over of the false cords. But in patients with dysphonia plica ventricularis, the associated muscular structures do not appear to be contracting. In this condition, the only structures moving regularly with the false cords are the true cords, and sometimes the false cords start first or seem to move more completely.

Jackson and Jackson suggested that patients with dysphonia plica ventricularis may have more than the usual amount of muscle

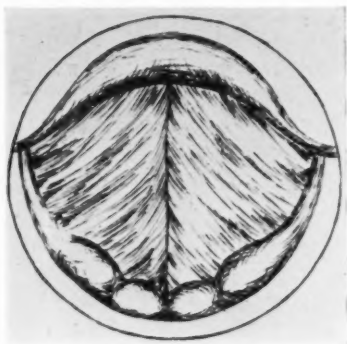


Fig. 3.—Dysphonia plica ventricularis, complete closure of false cords causing brief aphonia.

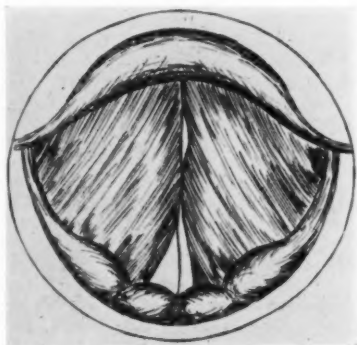


Fig. 4.—Dysphonia plica ventricularis, incomplete and irregular closure of false cords.

in the ventricular bands. I have made deep biopsies of the ventricular bands of several patients with dysphonia plica ventricularis and have not been able to demonstrate an increase in muscular tissue. Instead, there has been slight to moderate chronic inflammation and fibrosis. Squamous metaplasia and hyperplasia of the mucosa have been particularly prominent (Figs. 6A and 6B).

#### THE CAUSES

Jackson and Jackson separated dysphonia plica ventricularis into two groups: 1) a "vicarious" type caused by disease of the glottis itself (cords separated by tumor, cricoarytenoid fixation, surgical absence of one cord), and 2) a "usurpative" type due to vocal abuse, particularly when vocal abuse is associated with acute laryngitis. These are undoubtedly causes of many instances of dysphonia plica ventricularis. In a few patients, use of the false vocal cords is a desirable result, e.g., after hemilaryngectomy.

However, some patients with dysphonia plica ventricularis insist that they have not misused the voice, they deny laryngitis, and they show no visible evidence of organic laryngeal disease. These patients have been most hoarse during times of psychologic stress. Observant patients with insight sometimes recognize this relationship spontaneously. Here is a typical case report to emphasize the importance of the psychologic aspect of this disorder.

#### REPORT OF A CASE

A 22 year old negro girl worked as a hospital elevator operator. As part of her job she was required to challenge any passenger who did not present a "visit" slip. She was required to refuse to operate the elevator until the passenger obtained such a slip. Daily, unauthorized riders argued with her or verbally abused her.

After two weeks at this work, the patient became hoarse. Her work required her to use her voice very little, and she denied misuse of her voice at any time. She had never been hoarse before. She did not smoke or use alcohol and regarded herself as a calm person.

Indirect laryngoscopy showed a normal appearing larynx with both true cords of usual color and moving briskly. Just as the examiner started to withdraw the mirror, he saw the false cords close above the true cords and render the patient momentarily aphonic. He then studied the larynx at length. The false cords repeated their usurpative action several times, usually merely starting to close, or closing and opening quickly. The diagnosis of dysphonia plica ventricularis was made and the patient given reassurance that her throat was normal except for certain muscular overactivity. She accepted this explanation and left.

One week later the patient returned unimproved. In fact, she was more troubled than before by her hoarse, breaking voice. Laryngeal appearances were the same. Then she told of how she was periodically embarrassed at work. Arrangements were made to transfer her to an elevator not carrying hospital visitors. Immediately her symptoms disappeared. She has had no hoarseness since.

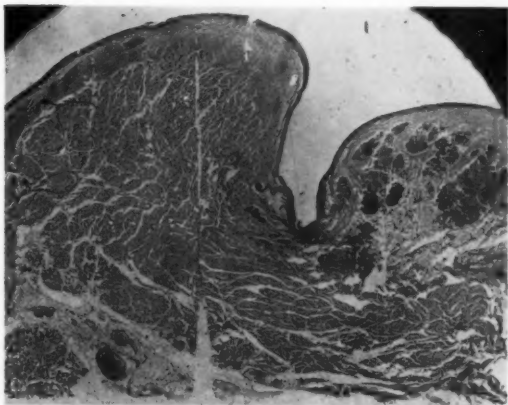


Fig. 5.—Normal larynx, showing abundant muscle tissue in true cord and scant muscle tissue in false cord.

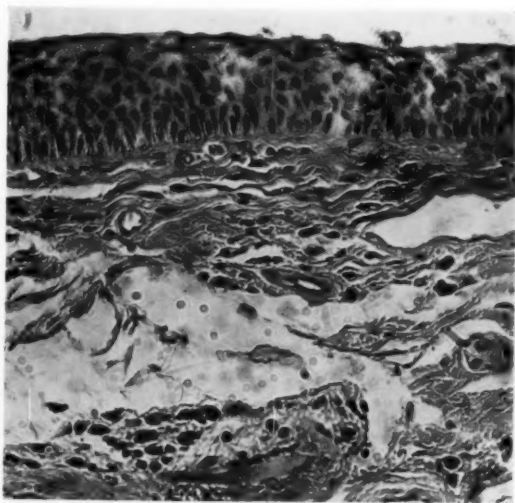


Fig. 6-A.—Normal transitional type mucosa of false vocal cord.



Fig. 6-B.—Squamous metaplasia and hyperplasia of mucosa of false cord in patient with dysphonia plica ventricularis.

#### TREATMENT

An operation is indicated only in patients who have remediable laryngeal disease at the glottic level. It may be possible to remove a vocal cord polyp or other tumor. Such removal, by restoring normal laryngeal function, permits the true cords to close and thereby relieves the false cords of their unaccustomed role.

Patients with dysphonia plica ventricularis having an otherwise normal larynx are questioned about their previous vocal habits, vocal abuse, laryngeal infections, smoking and drinking, and occupation. An attempt is made to estimate the patient's psychologic stability.

For want of a more definitive approach, I have patients observe a two week period of voice rest while relinquishing cigarettes and alcohol. A vacation is helpful not so much because of the rest but because the patient is temporarily separated from aggravating situations at home and at work. Patients who do not have a long history of hoarseness and who do not show hypertrophy of the ventricular bands do well on this regime. Patients who seem to have a definite psychologic factor causing their disability may improve temporarily only to return in several weeks or months complaining of the same symptoms.

Patients with hypertrophic ventricular bands have usually been hoarse for a long time. They often are seen for another complaint and the diagnosis dysphonia plica ventricularis made only incidentally. In my experience, the management of these patients requires more than a program of voice rest and restriction of smoking. Speech therapists may help in re-educating the patient to speak properly, but their techniques are not universally successful and some patients remain hoarse in spite of all efforts.

#### SUMMARY

Dysphonia plica ventricularis is a common cause of hoarseness and one which is frequently overlooked. Patients with this disorder present various patterns of hoarseness, and a prolonged mirror examination of the larynx may be necessary to establish the diagnosis.

The causes are both organic and functional. A case is reported to emphasize the importance of psychologic stress in producing this condition.

Early in the course of the disorder, patients usually respond to treatment, but some patients who have hypertrophic changes in the ventricular bands are likely to remain hoarse indefinitely.

UNIVERSITY HOSPITAL

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THE SIZE OF TRACHEOTOMY TUBES:  
ITS EFFECT ON VENTILATION OF RESPIRATOR  
PATIENTS WITH POLIOMYELITIS

ROBERT L. MARESCA, M.D.

AND

S. YOSHIYE OKINO, R.N.

LOS ANGELES, CALIF.

The maintenance of normal ventilation of respirator patients acutely ill with bulbospinal poliomyelitis is a sine qua non of their continued existence. During the "polio" season of 1954 we became impressed with the difficulty of such maintenance, and the thought occurred to us that the size of the tracheotomy tube was intimately involved in the ventilatory process. At a given pressure the rate of flow of a gas through a rigid tube is proportional to the square of the diameter of the orifice. Therefore a small increase in diameter means a larger flow rate.

SPECIAL CONSIDERATIONS

The effective diameter of a tracheotomy tube when used with a Bennett positive pressure attachment is the diameter of the adapter of the positive pressure apparatus which fits inside the inner cannula. (This can be overcome by a slight modification by which the adapter fits outside the tube. This is especially important in children.) For a #6 tube the adapter diameter is 6 mm, and for a #8 tube it is 8 mm.

Forty adult patients were studied. Twenty patients had #6 tracheotomy tubes and 20 had #8 tubes. Since we could not obtain a large series, the group was very carefully selected. We equated each patient in the #6 group to a patient in the #8 group with whom he closely corresponded. In making this equation the following factors were evaluated:

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This study was done at the Los Angeles County General Hospital, Communicable Disease Unit, Service of Dr. A. G. Bower.

From the Department of Otolaryngology, School of Medicine, University of Southern California, and the Los Angeles County General Hospital.



1. The severity of the illness—all were severely ill and in need of tracheotomy and respirator care.
2. Age and sex.
3. Height and weight.
4. Complicating afflictions other than polio per se, such as asthma, bouts of anoxia prior to our treatment, pregnancy, abdominal distension and aspiration of foreign material into the tracheobronchial tree.
5. Personnel involved in the patients' care. The same group was present for this entire study.

#### METHOD

The tracheotomy was performed by removal of a portion of the second tracheal cartilage in all patients. The #8 tube was not forced in; if it was not easily placed, a #6 tube was used. A Levine tube was inserted in all patients, following which they were placed in the respirator. Intratank negative and Bennett positive pressures were adjusted to the patients' needs, i.e., without using excessively high pressures we tried for the best tidal air we could get, and then dropped the pressures as low as was compatible with the maintenance of this. Tidal air was measured with a Bennett ventilation meter, with the patient's nose and mouth covered. Other aspects of the patient's care were kept exactly the same as they had been in other patients before this study was undertaken so as not to introduce variables in the interpretation of the data. A careful record was kept of the ease of suctioning, the amount of material obtained, the occurrence of atelectasis,  $p\text{CO}_2$  and the patient's subjective responses.

#### RESULTS

Table I shows the average intratank negative and Bennett positive pressures with the resulting average tidal air for each of the patients in the group with #6 tracheotomy tubes. The average of these values for the #6 group were as follows:

|   |            |
|---|------------|
| Average intratank negative pressure ..... | 12.5 mm Hg |
| Average Bennett positive pressure .....   | +9 mm Hg   |
| Average tidal air .....                   | 376 cc     |

Table II gives the same information for the group with #8 tubes. The averages are as follows:

|  |          |
|--|----------|
| Average intratank negative pressure..... | 10 mm Hg |
| Average Bennett positive pressure.....   | +8 mm Hg |
| Average tidal air.....                   | 519 cc   |

In patients provided with #8 tubes, using slightly lower pressures, the difference in the average tidal air was 143 cc.

#### COMMENT

In the #8 group there were three cases of atelectasis not requiring bronchoscopy, and in the #6 group there were nine cases, of which three required bronchoscopy.

There were no early or late untoward effects on the tracheal surface attributable to the size of the tube in those with the #8 tube.

Several observations made by the staff, in which we concur, were as follows:

#### ADVANTAGES OF THE #8 TRACHEOTOMY TUBE

##### 1. In regard to ventilation:

- a) As shown above we were able to use slightly lower pressures to maintain an adequate tidal air.
  1. In case it became necessary to raise the pressure settings because of respiratory emergency, there was a greater margin through which they could be raised.
  2. The patient on the lower pressures was more comfortable while maintaining large tidal airs.
- b) If there were collections of mucus in the larger tracheotomy tubes, the patients did not complain so much of air hunger, and were not so quickly in obvious distress, since the mucus was much less likely to cause complete or almost complete obstruction.
- c) It was easier to obtain adequate tidal air on positive pressure alone, so that patients could be brought out of the respirator for emergency surgery or complicated nursing care.
- d) The larger tube did not allow as much leakage back out through the nose and mouth.

TABLE I.  
#6 TRACHEOTOMY TUBES

| CASE NO. | PRESSURES | TIDAL AIR |
|----------|-----------|-----------|
| 1.       | +11, -13  | 450 cc.   |
| 2.       | +11, -15  | 300 cc.   |
| 3.       | +10, -14  | 350 cc.   |
| 4.       | + 9, -13  | 400 cc.   |
| 5.       | +10, -12  | 425 cc.   |
| 6.       | + 9, -16  | 400 cc.   |
| 7.       | + 9, -11  | 425 cc.   |
| 8.       | + 9, -15  | 325 cc.   |
| 9.       | +10, -12  | 350 cc.   |
| 10.      | +10, -12  | 600 cc.   |
| 11.      | + 7, -17  | 350 cc.   |
| 12.      | +10, -12  | 300 cc.   |
| 13.      | +10, -12  | 400 cc.   |
| 14.      | +11, -13  | 400 cc.   |
| 15.      | + 9, -11  | 425 cc.   |
| 16.      | + 7, -11  | 350 cc.   |
| 17.      | + 7, - 9  | 375 cc.   |
| 18.      | + 7, -14  | 300 cc.   |
| 19.      | + 6, - 8  | 325 cc.   |
| 20.      | + 8, -15  | 275 cc.   |

TABLE II.  
#8 TRACHEOTOMY TUBES

| CASE NO. | PRESSURES | TIDAL AIR |
|----------|-----------|-----------|
| 1.       | + 8, -10  | 575 cc.   |
| 2.       | + 5, - 7  | 500 cc.   |
| 3.       | + 7, - 9  | 500 cc.   |
| 4.       | + 7, - 9  | 500 cc.   |
| 5.       | +10, -15  | 525 cc.   |
| 6.       | + 7, - 9  | 500 cc.   |
| 7.       | +10, -12  | 575 cc.   |
| 8.       | + 8, -10  | 550 cc.   |
| 9.       | +10, -12  | 450 cc.   |
| 10.      | + 9, -11  | 450 cc.   |
| 11.      | + 7, - 9  | 500 cc.   |
| 12.      | + 9, -11  | 500 cc.   |
| 13.      | + 9, -11  | 525 cc.   |
| 14.      | + 4, - 7  | 500 cc.   |
| 15.      | + 8, -10  | 550 cc.   |
| 16.      | + 7, - 9  | 500 cc.   |
| 17.      | + 8, -10  | 525 cc.   |
| 18.      | + 9, -11  | 550 cc.   |
| 19.      | + 8, -10  | 550 cc.   |
| 20.      | + 9, -11  | 550 cc.   |

## 2. In regard to management other than ventilation:

- a) Suctioning was easier through the larger tube.
- b) In the coughing procedures more mucus was obtained with less effort.
- c) We found it easier to change from a #8 to a smaller size than to dilate a small stoma to insert a #8.

## DISADVANTAGES OF THE #8 TRACHEOTOMY TUBE

## 1. In regard to ventilation:

- a) Patients had the tendency to become hyperventilated easily, for example, in a patient with atelectasis, as this cleared, it was necessary to be very sure that the pressures were turned down at close intervals to avoid hyperventilation.
- b) There was a larger variation in tidal air with small changes in pressure settings—e.g., a change of 2 to 4 mm would often give a difference of 100-125 cc. This made it somewhat difficult to make a gradual change in the amount of air.

## 2. In regard to management:

- a) When we were running the tank on low pressure settings, an occasional patient complained of feeling as if he were not getting enough air, even though the measured tidal air was adequate, and there was no obstruction.
- b) It was necessary to decrease the size of the tracheotomy tube when the patients had recovered to the point at which we wished to plug it. We could plug very few #8 tubes. Decreasing the size is easy to do, and does not represent a serious objection to the #8.

While the main study was in progress we had the opportunity of applying to several children what was being learned. Below are some data obtained in representative cases not included in our original study.

| AGE | TUBE SIZE | PRESSURES | TIDAL AIR     |
|-----|-----------|-----------|---------------|
| 2   | #3        | +13, -15  | 125 - 150 cc. |
| 2   | #4        | +13, -15  | 175 - 200 cc. |
| 3   | #2        | +17, -19  | 100 - 125 cc. |
| 3   | #4        | +8, -12   | 125 - 150 cc. |

## SUMMARY

The influence of tracheotomy tube size on the tidal air of poliomyelitis patients in the respirator was studied in 40 very carefully selected patients, all of whom were adults, 20 with a #6, and 20 with a #8 tracheotomy tube. The average increase in tidal air when the #8 was used was 143 cc. Several important advantages and disadvantages became apparent as the study progressed. These are presented in the discussion in outline form.

It is possible to ventilate adult respirator patients more easily through #8 than through #6 tracheotomy tubes.

Careful management is required to avoid hyperventilation of such patients.

The advantages of the larger tube outweigh the disadvantages.

1843 WORKMAN ST.  
LOS ANGELES 31, CALIF.

THE HISTOLOGY OF THE HUMAN OLFACTORY  
BULB AND THE EXTRACEREBRAL  
PART OF THE TRACT

A STUDY WITH SILVER-CARBONATE

LEOPOLD LISS, M.D.

ANN ARBOR, MICH.

The purpose of the present investigation is to extend the knowledge of the histology of the olfactory bulb in man, since the development of the silver-carbonate method of del Rio Hortega<sup>1-3</sup> permits a more detailed analysis of the histology of this structure.

Autopsy material was carefully selected in order to eliminate postmortal or pathologic changes. Specimens were fixed in brom-formalin and cut on the freezing microtome at 15 microns in transverse, vertical and horizontal planes and were treated with numerous variants of the silver-carbonate technique according to requirements. Part of the material was fixed in alcohol, embedded in celloidin and stained with cresyl-violet and toluidin-blue.

Study of the literature reveals that knowledge of the histologic structure of the olfactory bulb is based almost exclusively on investigation of animal material.<sup>4-6</sup> Cajal used the silver-chromate technique (Golgi) and distinguished in animals seven layers: 1) the peripheral or superficial neural and fibrillary layer which is formed by nonmyelinated nerve fibers and small neurons; 2) the glomerular layer with several strata of large and small glomeruli and their cellular components; 3) the molecular or external plexiform layer constituted of dendrites of tufted and mitral cells; 4) mitral cell layer built of concentric laminae of multipolar neurons; 5) the inner plexiform layer or layer of collateral neurites which consists of tufted cells and neurites of the mitral elements; 6) the internal granular layer consisting of small neurons and myelinated and nonmyelinated nerve fibers; 7) epithelial lining of the bulbar ventricle.

Winkler<sup>6</sup> distinguished in rabbits three main layers but subdivided them into ten secondary layers.

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From the Laboratory of Neuropathology, Neuropsychiatric Institute, University of Michigan Hospital, Ann Arbor, Michigan.

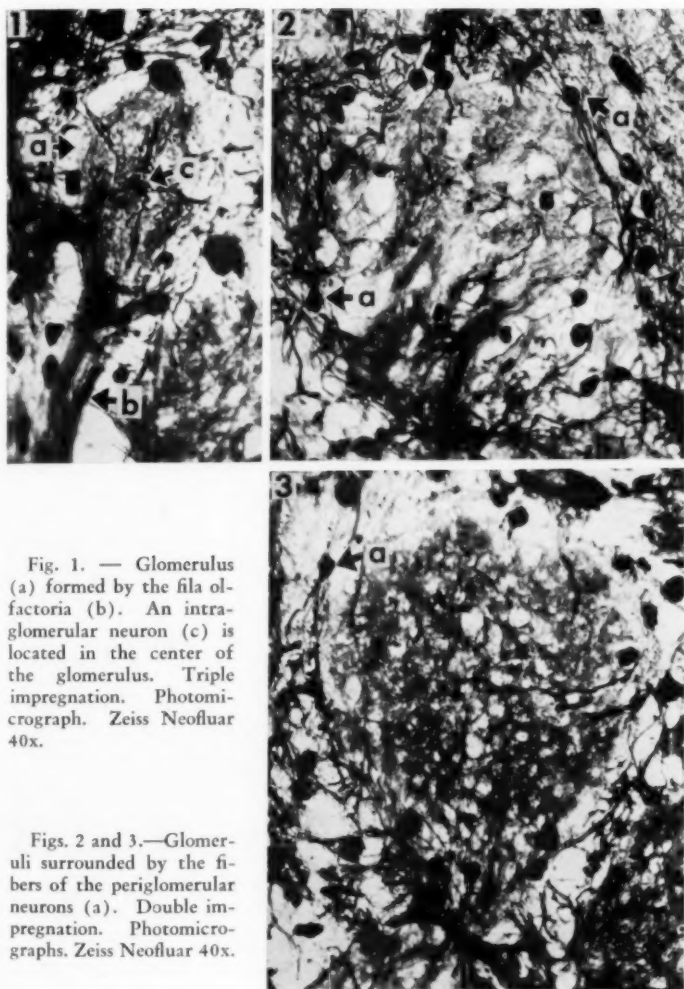


Fig. 1. — Glomerulus (a) formed by the fila olfactoria (b). An intra-glomerular neuron (c) is located in the center of the glomerulus. Triple impregnation. Photomicrograph. Zeiss Neofluar 40x.

Figs. 2 and 3.—Glomeruli surrounded by the fibers of the periglomerular neurons (a). Double impregnation. Photomicrographs. Zeiss Neofluar 40x.



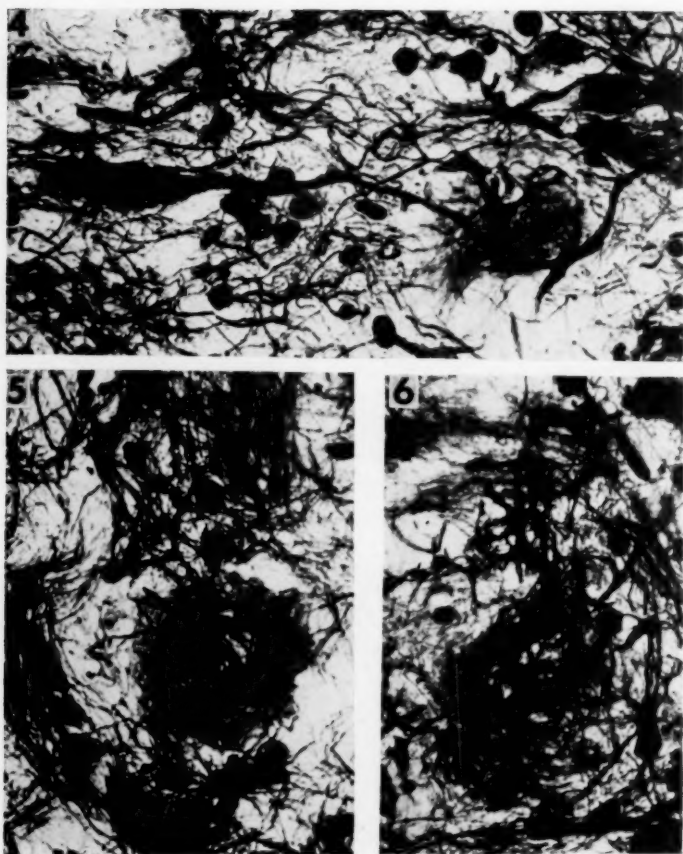


Fig. 4.—Mitral cell with long thick dendrite one branch of which enters glomerulus. Triple impregnation. Photomicrograph. Zeiss Neofluar 40x.

Figs. 5 and 6.—Intraglomerular fibrillar structure formed by the dendrites of mitral cells (the bodies of these cells are not in the picture). Triple impregnation. Photomicrograph. Zeiss Neofluar 40x.

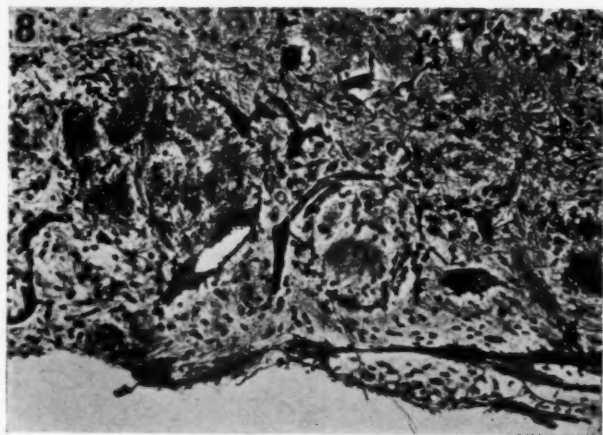


Fig. 7.—Large astrocytes which form a dense network around glomerulus. Astroglia method. Photomicrograph. Zeiss Neofluar 40x.

Fig. 8.—Network of blood vessels in the glomerular layer. Triple method. Photomicrograph. Zeiss Neofluar 6.3x.

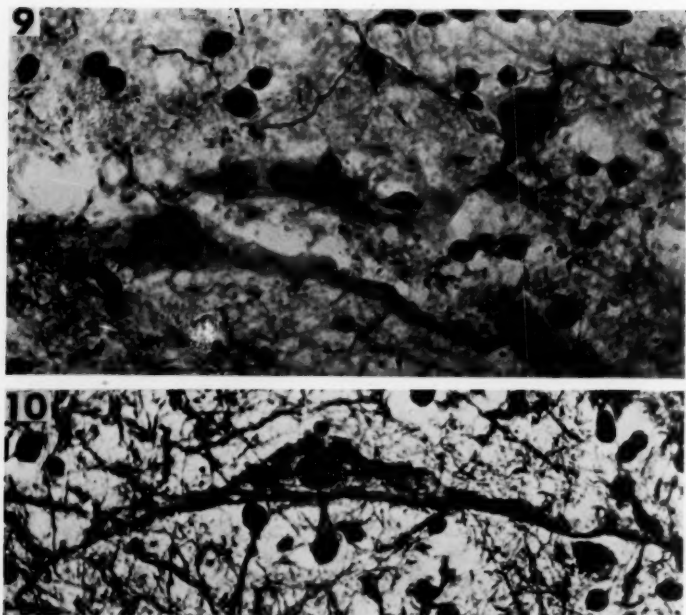


Fig. 9.—Mitral cells with distinct round or elongated nuclei and interconnected protoplasmic processes. Double impregnation. Photomicrograph. Zeiss Neofluar 40x.

Fig. 10.—Mitral cell with several small neurons which are connected with it. Triple impregnation. Photomicrograph. Zeiss Neofluar 40x.

In man, Brunner<sup>7</sup> and Weiss and Brunner<sup>8</sup> recognized five layers.

#### HISTOLOGIC DESCRIPTION

In the human olfactory bulb we have been able to differentiate four layers:

*First Layer.* This consists of nonmyelinated fibers of the fila olfactoria which originate in the sensory neurons of the nasal mucosa (Fig. 1).

*Second or Glomerular Layer.* The glomeruli are made up of a dense network of intertwined fibers of the fila olfactoria and small neurons which have a round body and numerous processes (Figs. 1-3). In the center of the glomerulus there is a distinct spherical bundle formed by well developed, coarse dendrites of mitral cells (Figs. 4-6).

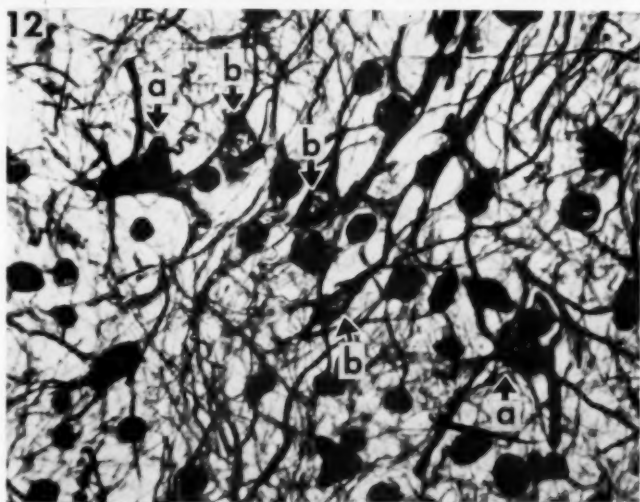
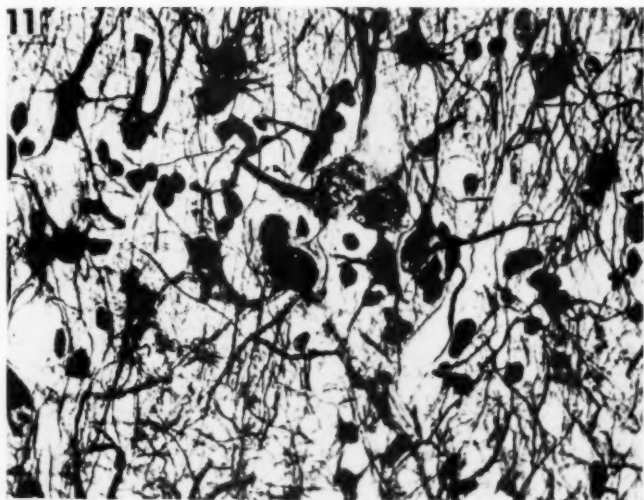


Fig. 11.—Group of large neurons surrounded by fibrillary astrocytes. Astroglia method. Photomicrograph. Zeiss Neofluar 40x.

Fig. 12.—Group of mitral (a) and tufted (b) cells. Double impregnation. Photomicrograph. Zeiss Neofluar 40x.

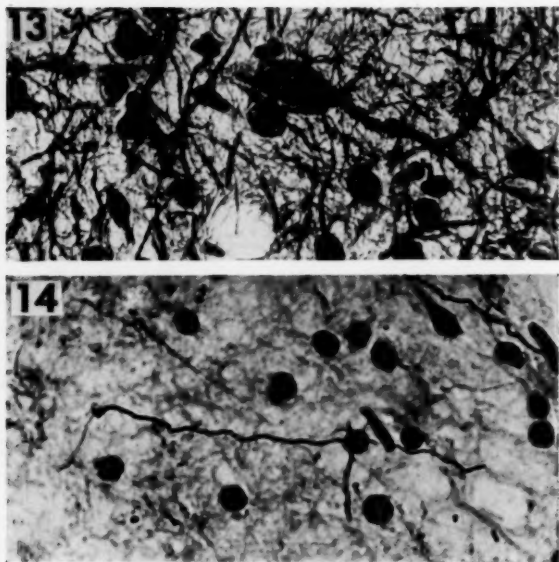


Fig. 13.—Bipolar cell from ganglionic layer surrounded by small neurons. Double impregnation. Photomicrograph. Zeiss Neofluar 40x.

Fig. 14.—Small neuron of stellate type (ganglionic layer). Double impregnation. Photomicrograph. Zeiss Neofluar 40x.

It is implied from Figure 4 that a single process of a mitral cell supplies more than one glomerulus. The entire glomerulus is surrounded by a dense capsule of astroglia (Fig. 7) and numerous vessels (Fig. 8).

*Third or Ganglionic Layer.* This is a complex structure which consists of six types of interconnected neurons:

a) The mitral cells are the largest elements, they are pyramidal in shape with a large, round central nucleus, and coarsely granular cytoplasm; these neurons have two or three very long thick processes which, as already mentioned, form the central core of the glomeruli. The mitral cells are arranged either in an indistinctly outlined network with large, irregular meshes (Fig. 9), or in small clusters, but do not form a separate layer. The spaces between the mitral cells contain mostly small stellate neurons connected with the mitral elements (Fig. 10).

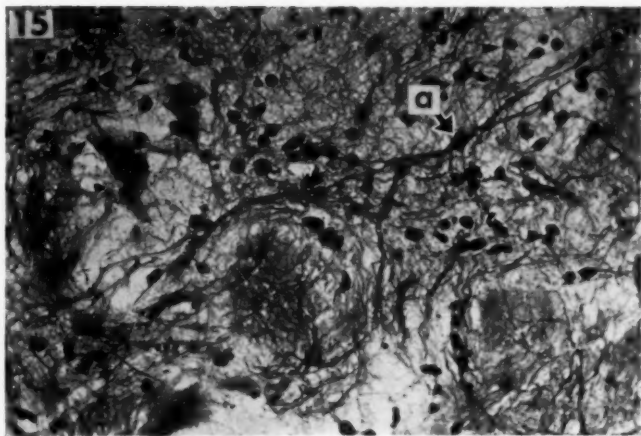


Fig. 15.—Small neuron (a) with numerous processes some of which surround a glomerulus while others intermingle with the fibers of the ganglionic layer. Double impregnation. Photomicrograph. Zeiss Neofluar 40x.

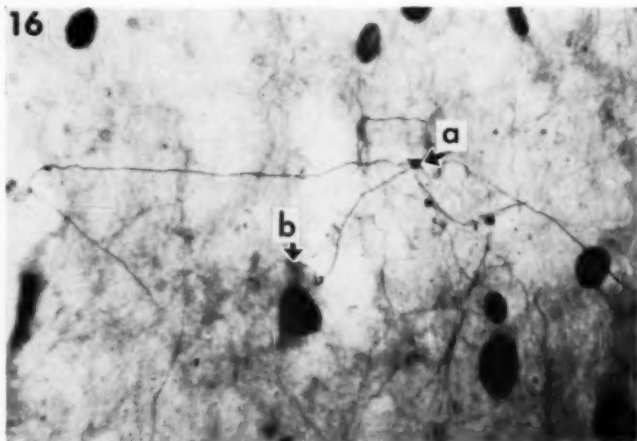


Fig. 16.—Ganglionic layer. Minute neuron (a) with long thin processes which end on bodies of large neurons (b). Double impregnation. Photomicrograph. Zeiss Neofluar 40x.

b) The tufted neurons are smaller than the mitral elements, oval or round in shape with a large round nucleus, scanty cytoplasm, and numerous long processes. Small groups of these elements are intermingled with the mitral cells and astroglia (Figs. 11 and 12).

c) The large bipolar neurons are few in number, do not have direct contact with the glomeruli but have rich connections with elements of the stellate type (Fig. 13).

d) The small stellate neurons have a round body and relatively well-developed radiating processes. These elements are very numerous and represent the prevalent type of small neurons in the ganglionic layer (Fig. 14).

e) Small neurons with a round body and numerous very long forked processes some of which surround the glomeruli while others pass through the entire ganglionic layer and are lost among the fibers of the olfactory tract (Fig. 15).

f) Minute neurons with a round body and several extremely long processes all of which are connected with the mitral and tufted neurons (Fig. 16). These elements have not previously been described.

*The Fourth Layer—Fibers of the Olfactory Tract.* This layer is not sharply demarcated from the ganglionic layer. It is characterized by parallel arrangement of myelinated and nonmyelinated nerve fibers. Between the fibers of the tract there are neurons of three types:

a) Large bipolar neurons which are present in the nerve fiber layer of the bulb and continue throughout the entire length of the extra cerebral part of the tract (Fig. 17). These cells have not previously been described.

b) Large multipolar neurons with two thick, long polar and several radiating processes (Fig. 18).

c) Small ovoid neurons with two long processes which originate from the same pole of the cell and which run parallel to the nerve fibers of the tract (Fig. 19).

#### COMMENT

The histologic structures of the human bulbus olfactorius are less well differentiated than those in macrosmatic animals.

The first layer, that of the fila olfactoria, is in man fundamentally similar to that in animals but contains fewer fibers and cells. This



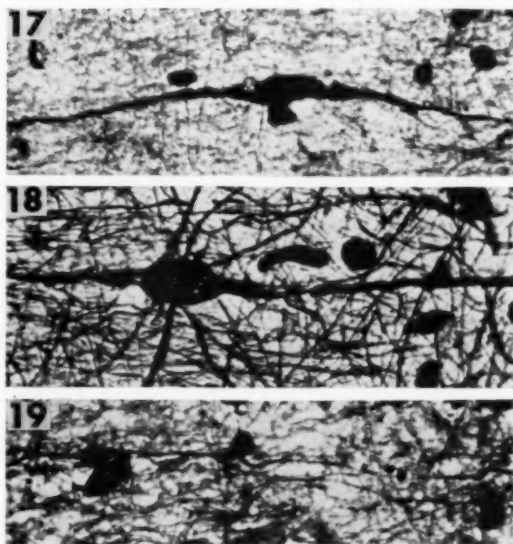


Fig. 17.—Large bipolar neuron (from the olfactory tract). Double impregnation. Photomicrograph. Zeiss Neofluar 40x.

Fig. 18.—Large multipolar neuron (from the layer of olfactory tract fibers). Triple impregnation. Photomicrograph. Zeiss Neofluar 40x.

Fig. 19.—Small ovoid neuron with two long processes (from the layer of olfactory tract fibers). Double impregnation. Photomicrograph. Zeiss Neofluar 40x.

is in accordance with the hypothesis that the number of fibers and cellular elements is related to the acuity of the sense of smell.<sup>9</sup>

The structure of the second or glomerular layer is characterized by numerous glomeruli which are formed by fibers of the fila olfactoria numerous peri- and intraglomerular neurons and contain in the core the main synaptic apparatus. This central core obviously represents the relay center which connects the neurons of the first order (those of fila olfactoria) with those of the second order (mitral and tufted cells). This structure has not previously been described either in man or in animals. Cajal<sup>4</sup> stated that in animals the processes of mitral and tufted cells enter the network of the glomerulus and intermingle with its fibers, but did not mention the central core which is so conspicuous in silver-carbonate preparations. The entire glomerulus is surrounded by a capsule of supporting astroglia and numerous

vessels. The astroglia cells in man are large, in contrast to the small periglomerular glia described by Cajal in animals.

The third or ganglionic layer in man consists of large and small neurons: to the first variety belong the mitral, tufted and bipolar cells, to the second the stellate, small and minute neurons. In man the cellular elements of the third layer are so closely intermingled that a subdivision into layers is not possible. This structure differs considerably from that described in animals by Cajal who distinguished three well-defined layers.

In the fourth or fibrillary layer fibers are arranged in a characteristic parallel formation and are intermingled with astroglia and small and large neurons. The latter variety is present in the bulbus and throughout the extracerebral part of the tract. In animals Cajal mentioned only small neurons.

The bulbar ventricle which in mammals is lined by ependyma (Cajal) is not present in man. In the human embryo Weiss and Brunner described numerous ependymal cells in the central portion of the bulbus but stated that they disappear in early postuterine life.

Although we examined olfactory bulbs of humans ranging in age from 18 months to 80 years we did not find evidence of degeneration of neurons as reported by Smith<sup>10</sup> and by Brunner. In our material there was an increase of the astroglia and of corpora amylacea in the advanced age group (between 70 and 80) which is common in the senile brain.

#### SUMMARY

Investigation of the human olfactory bulb with silver-carbonate shows that there are only four distinctly outlined layers: 1) fila olfactoria; 2) glomeruli; 3) ganglion cells and 4) olfactory tract fibers.

Seven different types of neurons were described in the bulb, and three in the tract.

Synaptic structures in the glomeruli, minute neurons in the ganglionic layer and bipolar ganglion cells in the olfactory tract have been demonstrated; these structures and neurons have not previously been described.

UNIVERSITY OF MICHIGAN

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LVII

POSTURAL VERTIGO DUE TO UNILATERAL SUDDEN  
PARTIAL LOSS OF VESTIBULAR FUNCTION

JOHN R. LINDSAY, M.D.

AND

WILLIAM G. HEMENWAY, M.D.

CHICAGO, ILL.

This report deals with a group of cases of vertigo in which the similarity of clinical characteristics indicate a common etiology.

The main characteristics of this group have been a rapid onset of severe vertigo without deafness or signs of central nervous system disease followed by a gradual decrease in vertigo during the next few days or weeks with however a persistence of severe vertigo upon postural changes. This postural vertigo has then persisted for periods of a few weeks to over three and a half years. Seven of these cases which have been observed recently are included in this group. All were in the fifth, sixth or seventh decades of life at the time of the acute onset. The histopathologic findings in one of these provided the explanation for the acute attack and evidence bearing on the clinical course.

In this case the sudden onset of vertigo occurred in 1939 and the case eventually came to autopsy 13 years later. The histopathologic findings as they affected the inner ears and the peripheral vestibular system are presented. These are of special significance because of the characteristics of the acute episode and the prolonged postural vertigo which followed.

REPORT OF CASES

CASE 1. A female patient, aged 65 years, in apparent good health experienced severe vertigo on awakening and attempting to get out of bed. Vomiting occurred several times during the first 24 hours. There was a slight sense of discomfort in the right ear which recurred occasionally for about one month, but no tinnitus or subjec-

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tive loss of hearing. The vertigo improved slowly and in about one month she was ambulatory. Unsteadiness persisted and vertigo continued to recur on quick movement of the head and was pronounced on turning onto her right side while in the recumbent position. The patient had formerly been under observation in the Medical Department for recurring arthritic pains. The opinion had been given that she had no evidence of cerebral vascular disease. She was examined in the Neurology Department after the onset of dizziness where the diagnosis of "vascular accident in the right labyrinth" was made. When first seen in the Ear, Nose and Throat Department four weeks after the onset, the complaint was mainly of dizziness on movement and especially when turning on the right side or sitting up from the recumbent position.

The significant findings on the ear examination were as follows: The eardrums were normal. Hearing tests showed a bilateral elevation of pure tone thresholds, mainly for high tones (Fig. 1). The hearing loss was approximately 10 db greater in the right ear although the patient had not noticed a change in her hearing.

There was a spontaneous nystagmus to the left side in all positions of gaze when viewed under Frenzel's glasses (plus 20 diopter lenses). No complaint of vertigo was made with the head at rest in the upright position. On performing postural tests vertigo was reproduced when the patient turned onto the right side, and on sitting up from the recumbent position. The nystagmus was increased in intensity and did not reverse in direction.

Caloric stimulation of the right ear with water at 118° F and with ice water both failed to produce a definite change in the nystagmus. Caloric stimulation of the left ear with water at 80° caused cessation of spontaneous nystagmus, followed by nystagmus to the right for a few seconds.

The patient was observed on several occasions during the next two years, the last examination being made approximately two years after the onset. A faint nystagmus was still observed under the Frenzel's glasses with the eyes in the resting position and with gaze to the left side. The complaint of postural vertigo was still present as on previous examinations but was reduced in intensity. During the next several years this patient was occasionally seen in the Medical Department.

Thirteen years after the onset of the vertigo she was found at home in a comatose condition. Death occurred from coronary thrombosis. The temporal bones were removed about 12 hours after death and placed in degassed formalin solution, 20 per cent. They were

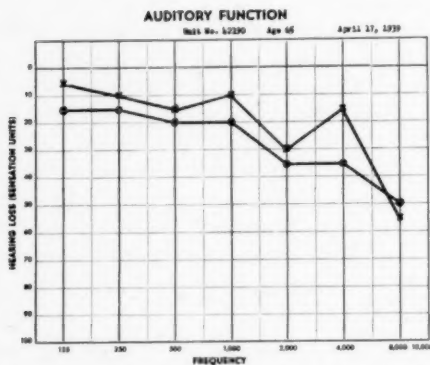


Fig. 1.—Case 1. Pure tone air conduction thresholds made one month after the onset of the attack of vertigo in 1939. Right ear showed slightly greater impairment than the left.

decalcified with a mixture of nitric acid, 2 per cent, and formalin 10 per cent.

**Histopathologic Findings.** The state of preservation of the membranous structure was similar in both ears. Both showed abnormalities which were interpreted as due in part to postmortem degeneration and in part to artifacts caused by the method of preparation. Other than these bilateral symmetrical changes the left ear showed no essential pathology while the right ear presented definite pathologic changes affecting the vestibular system.

**Cochlea.** The cochlea of both ears showed a normal appearing scala vestibuli and scala tympani. The membranes throughout had a shrunken appearance. The cochlear duct showed changes on both sides consisting of shrinkage of the organ of Corti into a more or less amorphous mass of cells lying on the basilar membrane. There was shrinkage of the stria vascularis, the tectorial membrane and Reissner's membrane. The latter was adherent to the tectorial membrane and to the organ of Corti in some areas (Fig. 2). The spiral ganglion showed some diminution of ganglion cells and nerve fibers particularly in the basal coil on both sides.

**Comment.** The abnormalities evident in the cochlear duct on both sides were interpreted as being due to the technique used in preparation of the material.

**Vestibular System.** The vestibular system on both sides also showed a similar shrinkage of the receptor organs to the extent that

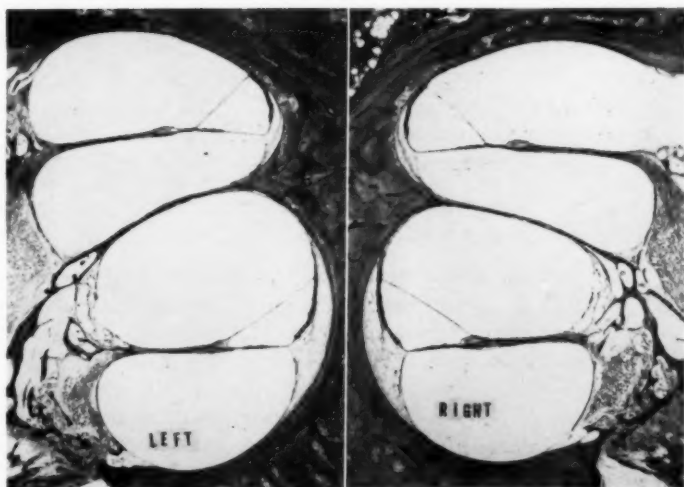


Fig. 2.—Case 1. Photomicrographs of corresponding sections through both cochlea magnification X50. The alterations in soft tissue structures, particularly in Corti's organ, stria vascularis, tectorial membrane, Reissner's membrane and spiral ganglion are similar on both sides and considered due to technique of preparation.

no information was afforded as to the state of the sensory epithelium in the various receptors. The general outlines of the membranous labyrinth and receptor organs were similar in both ears.

The left ear showed the vestibular nerve to be apparently normal in all its branches, including the ganglion of Scarpa. The facial and cochlear nerves also appeared to be normal in the internal auditory meatus.

The right ear showed definite histopathologic changes. These consisted as follows: There was in the internal auditory meatus a mass of convoluted vessels varying in size from one relatively large vessel to many very small vascular channels many of which lay closely related to and within the vestibular nerve at the ganglion of Scarpa (Fig. 3). The VII nerve and the cochlear division of the VIII nerve were deviated in their course but appeared to be otherwise normal. Scarpa's ganglion showed marked degenerative changes. There was apparently complete degeneration of the nerve fibers from the ganglion to the utricle and the ampullas of the horizontal and superior semicircular canals (Fig. 4). The vestibular nerve proximal to the vascular mass



was mostly absent from the specimen. The nerves to the posterior semicircular canal and to the saccule appeared to have the same density of nerve fibers as the corresponding nerves in the opposite ear (Fig. 5).

*Summary of Histopathologic Findings.* There were moderate bilateral postmortem degenerative changes. Also there was marked shrinkage of all membranous structures in both ears due to the method of preparation of the specimens.

**Left Ear:** There was a reduction in the number of ganglion cells and nerve fibers in the spiral ganglion of the basal coil.

**Right Ear:** 1. There was a moderate reduction in the number of ganglion cells and nerve fibers in the spiral ganglion in the basal coil. 2. There was a mass of vessels localized at and within Scarpa's ganglion in the internal auditory meatus consisting of one or more large tortuous vessels displacing the nerve and many small vessels situated within the ganglion. 3. There was marked degeneration of the ganglion cells in Scarpa's ganglion and degeneration of the nerve to the utricle and the superior and horizontal semicircular canals.

*Comment.* The degenerative changes localized to the ganglion of Scarpa and the superior division of the vestibular nerve on the right side can be definitely related to the episode of severe vertigo which occurred 13 years earlier. The negative response to caloric stimulation of the right side was explained by the degeneration of the nerves to the horizontal and superior semicircular canals. Failure to obtain a response to caloric stimulation does not rule out the existence of some degree of semicircular canal function.

The sudden onset of severe vertigo followed by postural vertigo which persisted for over two years can be attributed most probably to vascular occlusion thrombotic in nature occurring at the site of the localized mass of blood vessels connected with the vestibular nerve at Scarpa's ganglion, with resulting degeneration of part of the ganglion and of the superior division of the vestibular nerve.

**CASE 2.** S.R., a white male, aged 48 years, was referred for examination on March 4, 1955. About one month earlier he had awakened in the morning with dizziness and nausea. No deafness or tinnitus noticed. No headache. He remained in bed at home for five days, then was in the hospital for three days. Treated by intravenous histamine daily for three days. His chief complaint one month after the onset was dizziness on lying down, on turning onto either side when recumbent, and on sitting up. He was unsteady on walking and was afraid to walk around the house or go on the street alone. One month after onset the general and neurological examinations



Fig. 3.—Case 1. Photomicrographs X15 through the internal meatus on right side. Several abnormally large blood vessels (V) have displaced the cochlear nerve. Many small vessels are seen within Scarpa's ganglion. Degeneration of the ganglion (SG) and vestibular nerve is evident at this magnification.

showed no abnormality. Several examinations had been made in previous years for minor complaints. Blood pressure was never elevated but sometimes below normal. Hearing was normal in both ears. He had a spontaneous nystagmus to the left of second degree when examined under +20 diopter lenses. Head shaking did not increase the nystagmus.

*Postural tests.* Dizziness was complained of on lying down quickly, on turning on to either side while recumbent and on sitting up, but was of short duration. Positional nystagmus was not definite. Cold caloric stimulation gave a normal response on the left side and slightly diminished response on the right. Four months after the onset he still felt unsteady on walking. No spontaneous nystagmus. No nystagmus on head shaking. Some dizziness still occurred on sitting up quickly in the morning. Had returned to part time work but was apprehensive because of unsteadiness.

*Impression.* Vascular accident, probably occlusion, affecting the vestibular system.

Localization was indefinite. The slightly inequality of caloric responses and the spontaneous nystagmus to the left suggested the right side.

CASE 3. C.S., a white male, aged 60 years. Dizziness for six months was the complaint of this patient when seen in the Ear, Nose and Throat Clinic on March 5, 1956. He had experienced a sudden attack of severe vertigo six months earlier which lasted for ten days. He felt as "though the room was turning around him." The dizziness had improved considerably but he still had slight dizziness on turning his head quickly and while in the dark. Hearing had been diminished for several years but was no worse since the attack. He did not complain of tinnitus. A sister had had a similar attack several years previously.

The routine ear, nose and throat examination was negative. There was no spontaneous nystagmus. Caloric stimulation showed slightly diminished responses in right ear. On postural tests vertigo was produced with a positional nystagmus to the left when he turned both on his right side and on his left side. One month later he no longer complained of dizziness. The responses on caloric examination were the same as on the previous examination and postural tests reproduced positional nystagmus as before but without a complaint of vertigo. Neurological examination showed no sign of a central nervous system lesion. Hearing tests showed a bilaterally symmetrical high tone hearing loss, characteristic of presbycusis.

*Interpretation.* Sudden onset of vertigo without auditory symptoms followed by postural vertigo and nystagmus of over six months' duration.

*Etiology.* Vascular occlusion affecting the vestibular system. Arterio-sclerotic heart disease.

*Localization.* Indefinite. The right vestibular system was suspected because of diminished caloric response and the direction of the positional nystagmus.

CASE 4. N.M., a female, aged 54 years. This very nervous lady stated that she had had a severe spell of dizziness about three and one-half years ago which lasted about three days. Ever since then she had complained of dizziness when she turned her head to the right and unsteadiness when walking outside. She complained of tinnitus in her left ear which began about the same time as the vertigo. She did not complain of hearing loss.

General ear, nose and throat examination was negative. There was no spontaneous nystagmus. Caloric responses were within normal

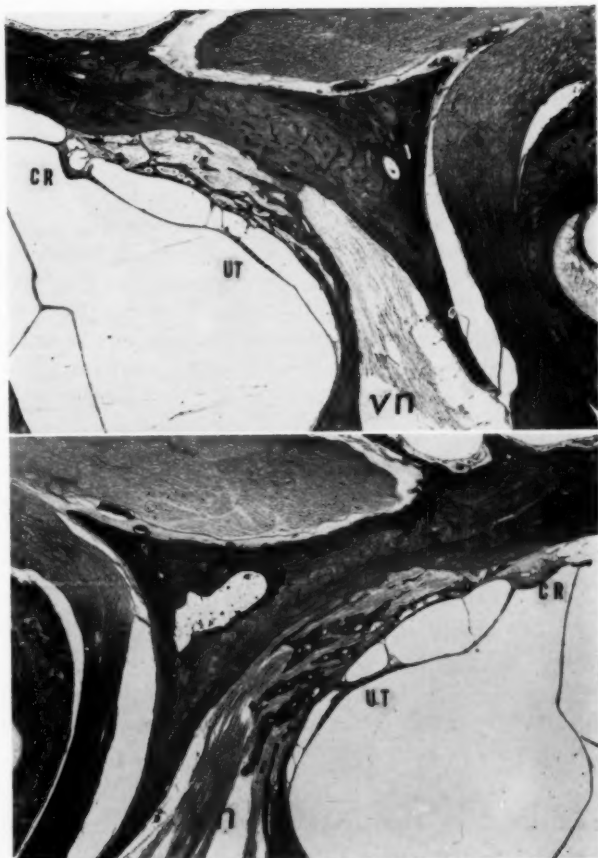


Fig. 4.—Case 1. Photomicrographs of section through superior division of the vestibular nerves (VN). Right ear (above) shows complete degeneration of nerve fibers. Left ear (below) shows normal nerve. The changes in the cristas (Cr) and utricular maculas (Ut) correspond to those shown in Figure 2 and are due to technique of preparation. No interpretation can be made as to the state of the sensory epithelium during life.

limits. Postural tests produced vertigo and positional nystagmus to the left with direction constant, on turning to either side, on stooping forward and on sitting up. Duration was about five seconds in each position. The audiogram showed bilateral early presbycusis. The neurological examination revealed no sign of disease of the C.N.S.

*Impression.* Vascular occlusion affecting probably the left vestibular system because of direction of positional nystagmus and tinnitus on left. Exact localization not known.

CASE 5. M.M., a white female, aged 57 years. When this patient was seen on September 30, 1954, she complained of dizziness since April 22, 1954, when on awakening in the morning she was unable to get out of bed because of intense vertigo which was made worse by movement. She was nauseated at the onset but did not notice hearing loss. At the time of examination (five months later) she had had no severe vertigo for the past six weeks but complained of tinnitus in the right ear and some dizziness on extending the neck backward.

The local findings on ear, nose and throat examination were normal. Hearing thresholds were normal in both ears. There was no spontaneous nystagmus. Caloric stimulation produced a response within normal limits in both ears. Postural tests produced vertigo and a positional nystagmus to the right on lying down and on raising up to the sitting position. It persisted only a few seconds.

*Impression.* Mild vascular occlusion, affecting the vestibular system.

Localization is indefinite. The presence of tinnitus suggested the right side but the direction of nystagmus was more suggestive of a left-sided lesion.

CASE 6. M.S., a white male, aged 53 years. This man was seen on August 30, 1955. Three months previously while driving his car he was suddenly seized with an attack of severe vertigo. He had been "under pressure" all day. The attack lasted several hours and gradually subsided. In the interval he had no severe attacks but had short episodes of vertigo on some changes of position. These had almost disappeared by the time he was examined. He had had tinnitus in his left ear for several years and felt it was louder during and immediately following the attack of vertigo. General ear, nose and throat examination was negative. Caloric stimulation showed the response to be normal in the right ear and diminished slightly in the left ear. Postural tests produced vertigo and a positional nystagmus to the left with the head extended over the end of the table and on

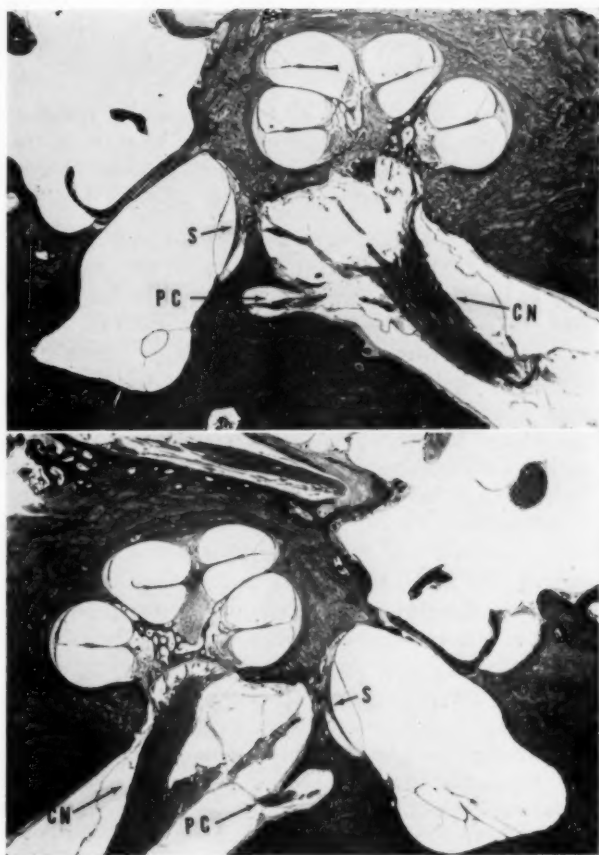


Fig. 5.—Case 1. Photomicrographs X12 of corresponding sections of both ears showing normal appearing saccular nerves and maculas (S), also normal appearing nerves to posterior canal ampullas (PC). The cochlear nerves (CN) are intact on both sides.

sitting up from the supine position. The audiogram showed moderate bilateral high frequency loss compatible with a diagnosis of presbycusis. On September 6, 1955, there were no symptoms. The symptom of postural vertigo persisted for approximately three months from the time of onset.

*Impression.* Mild vascular accident (occlusion).

*Localization.* Uncertain. The left vestibular system was suggested on the basis of the associated increase in tinnitus on the left and diminished response to caloric stimulation, but the direction of positional nystagmus suggested the right side.

CASE 7. B.D., a male, aged 56 years. This patient was seen in the Ear, Nose and Throat Clinic on February 24, 1956. Two weeks previously he had awakened in the morning and suddenly noticed that the objects in the room were spinning around. He was nauseated, felt weak and remained in bed for two days. Since then he had gradually improved. Two weeks later he continued to have vertigo on change of position, especially on sitting up in bed. He did not complain of tinnitus or hearing loss. General ear, nose and throat examination was negative. An audiogram showed pure tone thresholds to be normal for his age. He had a faint second degree spontaneous nystagmus to the left when examined with Bartel's glasses. Response to minimal cold caloric stimulation was about equal on the two sides on the first examination but slightly diminished on the right on two subsequent examinations. Postural tests reproduced vertigo on turning to either side while in the recumbent position and on sitting up, with a positional nystagmus to the left with direction constant. The vertigo passed off rapidly. General medical and ophthalmological examinations were negative. Three and a half months after the onset he still noted some vertigo on getting up in the morning. Although he sensed vertigo on postural tests no nystagmus was elicited.

*Impression.* Mild vascular occlusion, affecting the vestibular system probably on the right side.

Localization within the vestibular system was not indicated.

*Comment.* The clinical course in the latter six cases corresponds to that in Case 1 except that there was a wide variation in severity of the vertigo at the onset and in the length of time required for recovery.

Postural vertigo was characteristic in all cases after the initial constant and severe vertigo had subsided.



The positional nystagmus in these cases had constant direction and tended to disappear fairly rapidly.

Factors which may indicate the side on which the lesion is located are:

- a) Spontaneous nystagmus of fixed direction. The quick component usually is directed to the opposite side.
- b) Impaired responses to caloric stimulation.
- c) Positional nystagmus, if constant in direction, tends to indicate a lesion in the contralateral side.
- d) Tinnitus or deafness in one ear associated with the vertigo.

In this group the probable localization as to the side involved was suggested in all but Case 5, on the basis of direction of nystagmus, reduced responses to caloric stimulation and auditory symptoms. More exact localization within the vestibular system on one side (i.e., labyrinthine, retrolabyrinthine, nuclear) could not be made on a clinical basis alone.

#### COMMENT

Total destruction of one peripheral vestibular system is followed by severe vertigo. The recovery follows a well-known course and symptoms subside gradually. Vertigo upon quick movements of the head is experienced during the first six months or more, but postural vertigo is not a characteristic during the recovery period.

A gradual partial destruction of one labyrinth or of one vestibular nerve also does not cause a prolonged period of postural vertigo. An example of this is seen in the early stage of acoustic neuroma when vestibular function may be depressed or destroyed without vertigo as a prominent symptom.

Sudden or rapid partial destruction of one labyrinth has frequently been observed to cause a postural vertigo. At the onset the vertigo is continuous but as the symptom decreases it becomes postural in character and may persist for periods of time varying from a few weeks to two or three years.

Classical examples occur in the occasional unilateral partial destruction of function by a virus infection. For example, "mumps" frequently causes unilateral deafness and occasionally there may be severe vertigo as well, without destruction of the vestibular sense organs. The vertigo in such a case has been observed to have a postural characteristic and to persist for many weeks. In the case of

virus disease the infectious process has probably invaded the endolymphatic space and affected the sense organs directly as has been found to occur in the case of the measles virus.<sup>1</sup>

A sudden total unilateral destruction of both cochlear and vestibular function by an infectious process is not accompanied by prolonged postural vertigo but follows the usual course seen after acute destruction of one labyrinth by any other means.

*Vascular Accident.* Damage to the peripheral vestibular system due to vascular accident may take various forms.

*Hemorrhage.* Hemorrhage into the labyrinth has been known to occur in cases of leukemia and many descriptions of the histopathologic changes found in the labyrinth in such cases have been published. In some cases there has been a severe vertigo with only mild or partial loss of hearing. In most cases there has been profound loss of vestibular function as well as loss of hearing. Hemorrhage into the labyrinth is usually a late complication in leukemia and little information is available as to postural vertigo following the acute episode.

*Vascular Occlusion.* a) Total unilateral destruction of both auditory and vestibular function sometimes occurs in adult life in the absence of leukemia or other known systemic disease. A hemorrhage into the labyrinthine space has seemed a possible explanation in view of the findings in leukemia, however, a vascular occlusion can also explain a profound involvement of both cochlear and vestibular function and is a more probable explanation in the absence of leukemia or hemorrhagic disease. Obstruction of the venous flow from the labyrinth in the guinea pig<sup>2</sup> (Kimura & Perlman) has been shown to cause severe degeneration of both cochlear and vestibular sense organs. Obstruction to the main arterial supply also could cause total loss of function.

b) Sudden deafness without vertigo. A sudden onset of deafness without vertigo may occur and the hearing loss may be mild or profound. Partial recovery is common and in occasional cases even a severe grade of hearing loss may be followed by recovery to normal within a few weeks. It is probably in such cases that the pathologic lesion consists of vascular occlusion affecting only the blood supply to the cochlea due either to spasm or a calcareous plaque.

c) A common occurrence in adult life is a sudden onset of dizziness along with tinnitus and varying degrees of high tone deafness. Such cases usually show some degree of recovery in hearing during the first six weeks after the onset. Dizziness may be severe at the onset.

There is usually some depression of caloric excitability in the affected ear. Recovery is often characterized by a postural type of vertigo with positional nystagmus which can be reproduced for many months and sometimes has been reproducible for as long as three years. Recovery from the vertigo is eventually complete in almost all cases.

d) Another type of clinical course which is commonly observed is an acute onset of severe vertigo without auditory symptoms or in some cases with minimal auditory symptoms such as mild tinnitus or a sense of discomfort in the ear. The vertigo is constant and may be severe at the onset, but as it subsides it becomes mainly postural in character. The postural vertigo may persist for several weeks or as long as two or three years. It may be reproduced on postural tests and confirmed by the occurrence of positional nystagmus. The complaint of unsteadiness is common in such cases and may persist for many months.

The group of cases which forms the basis of this report falls into this latter category.

The inclusion of these four clinical groups under the etiologic heading "vascular occlusion" is an assumption based heretofore on clinical evidence. The histologic demonstration of a degenerative process localized to part of one peripheral vestibular nerve associated with a vascular lesion in this one case lends further support to this explanation. The experimental demonstration in animals of the degeneration produced by interruption of venous flow also demonstrates the exact nature of the degenerative process that may result.<sup>2</sup>

*Postural Vertigo.* The explanation of the prolonged postural vertigo which accompanies or follows certain peripheral labyrinthine lesions has presented difficulties. The assumption that the otoliths were responsible has seemed plausible, but certain objections to this explanation have not been overcome, namely, the failure to demonstrate that stimulation of a utricle or saccule either directly in certain lower animals or in the human by physiological stimulation in the human centrifuge, could produce nystagmus.

Clinical observation indicates that the type of peripheral labyrinthine lesion which is usually followed by prolonged postural vertigo is that in which the function has been partially destroyed by an acute process. The possibility that a disturbance of the utricle alone is concerned with the postural vertigo has not been clearly established. Cases with total unilateral acute destruction do not have prolonged postural vertigo. In Case No. 1 presented here the utricle as well as two semicircular canals could be considered as nonfunctioning. It appears therefore that the loss of the utricle was not alone responsible

for the prolonged recovery period with postural vertigo. The explanation appears to lie in the fact that part of the labyrinth remained active, in this case the saccule and the posterior canal.

The continuation of active impulses from part of the labyrinthine receptors with sudden loss (or impairment) of other receptors appears to be the situation which is characterized by postural vertigo and a positional nystagmus. The contribution of the various receptors remains in doubt.

#### SUMMARY

A group of cases of vertigo has been reported in which the etiology is considered to be a vascular accident affecting the vestibular mechanism on one side. The lesion is considered to be vascular occlusion. This group presented the common clinical characteristics of sudden onset of vertigo without deafness or central nervous system signs and a recovery period varying from several weeks to over three years characterized by postural vertigo.

The histopathological findings in one such case have been presented. The lesion consisted in degeneration of part of Scarpa's ganglion and of the nerves to the utricle, the superior and the horizontal semicircular canals on the affected side. A mass of fine convoluted vessels in the internal auditory meatus invading the ganglion of Scarpa indicated vascular occlusion as the etiology of the acute degenerative process.

The explanation for the prolonged postural vertigo from a peripheral vestibular lesion apparently lies in the sudden partial loss of function as opposed to either a slowly developing or a total destruction of the vestibular system on one side.

950 EAST 59TH ST.

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## LVIII

### POSITIONAL NYSTAGMUS IN ELDERLY PATIENTS WITH POSTURAL DIZZINESS

MATTI KOSKENOJA, M.D.

AND

ESKO J. ORMA, M.D.

HELSINKI, FINLAND

The most common form of dizziness in the aged is a momentary equilibrium disturbance due to a sudden movement of the head or the whole body, or, in rare cases, to some particular position. We have called it postural dizziness. In a previous study<sup>16</sup> in which a group of postural dizziness patients was compared with a control group without dizziness (all patients over 64 years of age), it was found that the postural dizziness group showed a significantly higher frequency of cerebral neurological, obviously arteriosclerotic, symptoms, cardiac failure, and mental symptoms possibly due to psychogenic factors as well as to arteriosclerotic or other degenerative cerebral damage. On usual otorhinolaryngological examination it was not possible to show any difference between the groups. But positional nystagmus was often found in patients suffering from postural dizziness.

Positional nystagmus is nystagmus which occurs only in one or several positions of the head, or nystagmus which is influenced by the position of the head. The posture test is considered a good and sensitive method of examining the vestibular system.<sup>14,15</sup> Positional nystagmus is regarded as an abnormal phenomenon,<sup>6,8,14,15</sup> indicating a disturbance in the vestibular system.<sup>14,15</sup> The disturbance can be in the inner ear, the nervus vestibularis, the vestibular centers and their connections in the brain. This has been proven in animal experiments, and positional nystagmus has been found in different otological and neurological diseases.<sup>2,3,5,7,11-15,18</sup>

#### MATERIAL AND METHODS

The material was composed of 103 postural dizziness patients and of 62 patients without dizziness. All subjects were over 64 years of age. The groups did not differ from one another in age or sex. The patients were examined in the same way. The examination in-

cluded physical, neurological, otorhinolaryngological and ophthalmological examinations.<sup>16</sup> Nystagmus was examined on the ordinary examination table in the following positions: sitting upright, leaning the body to the left and right, stooping forward, in the supine position, in the lateral position lying on the left and the right side, lying on the back with the head hanging (the so-called head-hanging position), and after quickly rising from the supine position. Our positions correspond in the main to those used by Nylén,<sup>13-15</sup> Lindsay<sup>11</sup> and Frenzel.<sup>7</sup> On the other hand, Cawthorne<sup>3</sup> used only few positions or movements in his posture tests. In our method the change from one position to the other happened fairly rapidly. In our posture tests nystagmus may obviously have been caused by the position as well as by the movement itself. The fistular test was negative in all the patients, and as far as possible neck torsion was avoided.

The classification of nystagmus was as follows:

1. Direction-changing positional nystagmus. In different positions the nystagmus has different directions. This type corresponds to Nylén's Type I and Seiferth's "Richtungswechselnder Lagenystagmus."

2. Direction-fixed positional nystagmus. The nystagmus has the same direction in all positions in which it occurs, or it occurs in one position only. This type corresponds to Nylén's Type II and Seiferth's "Richtungsbestimter Lagenystagmus."

3. Indefinite positional nystagmus. This is a nystagmus of short duration (< 10 sec.). We use this type because the nystagmus caused by the movement itself probably remains in this group, and because it is difficult, if not impossible, to judge the quality of a short nystagmus lasting only for a few seconds.

As far as the first two types are concerned our classification corresponds to that of Nylén, Seiferth and Lindsay, and in the main to that of Frenzel. Cawthorne, on the other hand, while separating the cases of positional nystagmus into two groups, the peripheral and the central type, takes into consideration not only the change of direction of nystagmus in the different positions, but also other features, such as the duration of nystagmus and the latent period between adopting the position and the onset of the nystagmus.

#### RESULTS

In the postural dizziness group, which consisted of 103 patients, positional nystagmus was found in 31 patients. It was direction-changing in five, direction-fixed in 19, and indefinite in seven cases.

TABLE I  
POSITIONAL NYSTAGMUS IN 103 PATIENTS  
SUFFERING FROM POSTURAL DIZZINESS

|   | THE TYPE OF POSITIONAL NYSTAGMUS |                           |                          |
|---|----------------------------------|---------------------------|--------------------------|
|   | DIR.-CHANGING<br>5 PATIENTS      | DIR.-FIXED<br>19 PATIENTS | INDEFINITE<br>7 PATIENTS |
| <i>Duration of Nystagmus</i>  |                                  |                           |                          |
| < 10 sec.   | —                                | —                         | 7                        |
| 10-30 sec.  | —                                | 7                         | —                        |
| Continuous  | 5                                | 12                        | —                        |
| <i>Direction of Nystagmus</i>                                       |                                  |                           |                          |
| Horizontal  | 2                                | 9                         | 4                        |
| Horizontal-rotatory   | 4                                | —                         | —                        |
| Rotatory  | —                                | 3                         | 1                        |
| Vertical  | 3                                | 7                         | 1                        |
| Diagonal  | 1                                | —                         | 1                        |
| <i>The Positions in Which<br/>Nystagmus Appeared</i>                |                                  |                           |                          |
| Leaning the Body to the Left  | 2                                | 6                         | 1                        |
| Leaning the Body to the Right                                       | 2                                | 3                         | 1                        |
| Stooping Forwards   | 2                                | 5                         | —                        |
| In the Supine Position  | 2                                | 6                         | —                        |
| Lying on the Left Side  | 1                                | 4                         | 1                        |
| Lying on the Right Side   | 1                                | 3                         | —                        |
| Lying Supine with the Head Hanging                                  | 4                                | 8                         | 2                        |
| After Rising from the Supine Position                               | 5                                | 11                        | 3                        |
| <i>The Number of Positions in Which<br/>Each Nystagmus Appeared</i> |                                  |                           |                          |
| 1   | —                                | 10                        | 6                        |
| 2   | 2                                | 4                         | 1                        |
| 3 - 7   | 2                                | 3                         | —                        |
| In all Used Positions   | 1                                | 2                         | —                        |

In five of the positional nystagmus patients a spontaneous nystagmus of the first grade appeared in the usual upright sitting position, but in the other 26 patients nystagmus appeared only in the posture tests. In addition to these cases, one patient had a spontaneous nystagmus which was not influenced by the positions. Some features of the positional nystagmus (duration, direction, positions in which it appeared and the number of these positions) are shown in Table I. In all cases positional nystagmus appeared as soon as the head reached the position. Only in three patients was the appearance of nystagmus associated by a subjective sensation of dizziness. In 13 patients the positions and movements which provoked positional nystagmus corresponded to the positions or movements in which their postural dizziness usually appeared.



TABLE II  
POSITIONAL NYSTAGMUS IN 62 PATIENTS  
WITHOUT DIZZINESS

|   | THE TYPE OF POSITIONAL NYSTAGMUS |                          |                          |
|---|----------------------------------|--------------------------|--------------------------|
|   | DIR.-CHANGING<br>NO PATIENTS     | DIR.-FIXED<br>5 PATIENTS | INDEFINITE<br>3 PATIENTS |
| <i>Duration of Nystagmus</i>                                    |                                  |                          |                          |
| < 10 sec.   |                                  | —                        | 3                        |
| 10-30 sec.  |                                  | 5                        | —                        |
| Continuous  |                                  | —                        | —                        |
| <i>Direction of Nystagmus</i>                                   |                                  |                          |                          |
| Horizontal  |                                  | 5                        | 2                        |
| Horizontal-rotatory   |                                  | —                        | —                        |
| Rotatory  |                                  | —                        | 1                        |
| Vertical  |                                  | —                        | —                        |
| Diagonal  |                                  | —                        | —                        |
| <i>The Positions in Which Nystagmus Appeared</i>                |                                  |                          |                          |
| Leaning the Body to the Left                                    |                                  | —                        | —                        |
| Leaning the Body to the Right                                   |                                  | 2                        | 1                        |
| Stooping Forwards   |                                  | 2                        | 1                        |
| In the Supine Position  |                                  | 2                        | —                        |
| Lying on the Left Side  |                                  | —                        | —                        |
| Lying on the Right Side   |                                  | —                        | —                        |
| Lying Supine with the Head Hanging                              |                                  | 2                        | 2                        |
| After Rising from the Supine Position                           |                                  | 1                        | —                        |
| <i>The Number of Positions in Which Each Nystagmus Appeared</i> |                                  |                          |                          |
| 1   |                                  | 1                        | 2                        |
| 2   |                                  | 4                        | 1                        |
| 3 - 7   |                                  | —                        | —                        |
| In all Used Positions   |                                  | —                        | —                        |

Positional nystagmus was also found in eight in the group of patients without dizziness (Table II). None of them had nystagmus in the sitting position.

Nystagmus appeared immediately without a latent period. No patient had an associated dizziness.

The group of patients with positional nystagmus was compared to the group of the patients without positional nystagmus. It was found that the positional nystagmus group had significantly more of such cerebral neurological signs obviously caused by cerebral arteriosclerosis. In the statistical treatment the neurological signs were divided into two groups: focal cerebral signs (or signs which clearly point to a local cerebral lesion), and diffuse cerebral signs, or signs



(rigidity, tremor, ataxia, inco-ordination, etc.) which are more difficult to localize and whose obvious cause is in the cerebellum or basal ganglions. Focal cerebral signs were found in 10 of the 39 patients with positional nystagmus and in 14 of the 126 patients without positional nystagmus. Focal or diffuse cerebral signs were found in 22 patients of the positional nystagmus group and in 41 patients of the group without positional nystagmus. The positional nystagmus group showed a higher frequency of cerebral signs whether of the focal ( $P < 0.05$ ) or both focal or diffuse together ( $P < 0.01$ ) when tested by the  $\chi^2$  test (or the chi-square test). In no other respect could a difference be seen between the patients with positional nystagmus and those without it. There was thus no difference between the groups in the frequency of otological diseases, in hearing acuity, or in caloric tests.

#### COMMENT

In this investigation, which included only patients of over 64 years of age, it was found that 31 out of 103 patients suffering from postural dizziness and 8 out of 62 control patients without dizziness had positional nystagmus. In these patients the typical features of positional nystagmus were that the nystagmus appeared immediately after the new position had been reached without any latent period, and that only a few patients had a subjective sensation of dizziness during the nystagmus. Only in five of these 39 positional nystagmus cases the nystagmus appeared also in the usual sitting position. Furthermore, one patient had a spontaneous nystagmus not influenced by position. In the absence of the posture test, the great majority of the nystagmus cases would have escaped notice.

Some findings indicate that positional nystagmus in these patients had a central etiology. The positional nystagmus patients were found to have significantly more of cerebral neurological signs, obviously caused by cerebral arteriosclerosis, than did the patients without positional nystagmus. No other difference could be shown to exist between these groups of patients. The absence of the latent period<sup>3</sup> and of associated dizziness during nystagmus,<sup>9,17</sup> and the frequent occurrence of vertical and diagonal directions<sup>6,9,10</sup> support the idea of a central etiology. This view is in agreement with the results of our study on postural dizziness in the aged,<sup>16</sup> according to which postural dizziness in the aged is to be considered a symptom of cerebral arteriosclerosis, cardiac failure, or some mental abnormality, its cause being most probably central in its location.

Positional nystagmus appeared in eight patients who had never had any dizziness. This frequency is significantly lower than that

of positional nystagmus in the postural dizziness group. Comparison of the non-dizziness and the dizziness group showed that the patients without dizziness never had positional nystagmus in the usual sitting position or direction-changing, continuous, vertical or diagonal positional nystagmus, whereas 21 out of the 31 cases of positional nystagmus in the dizziness group had one or more of these features. It is possible that the positional nystagmus which presents some of the above features may be clinically more important than a positional nystagmus without any of these features.

It has been stated that positional nystagmus is usually accompanied by a subjective sensation of dizziness.<sup>3,6,11</sup> In the present investigation it was found that positional nystagmus was rarely accompanied by dizziness and that it may appear also in patients without dizziness. These findings indicate that the subjective sensation of dizziness and nystagmus may be independent of one another. This is not a new discovery. Even in rotation tests with cupulometry, in which the semicircular canal organs are stimulated, it has been found that a nystagmus cupulogram does not agree with a sensation cupulogram.<sup>1,19</sup> Aschan et al<sup>1</sup> assume that "the subjective rotary sensation requires a complex impulse conducting system with participation of the cortex and association pathways; whereas the route of conduction, the reflex path, for nystagmus would have a relatively simpler pattern and in part use other pathways." Central nystagmus is seldom accompanied by dizziness,<sup>2,17</sup> because central nystagmus may originate outside the usual vestibular system.<sup>4</sup> It is therefore not surprising that central positional nystagmus can appear in persons without dizziness as well as be unaccompanied by a sensation of dizziness.

#### SUMMARY

Positional nystagmus has been examined in 103 patients with postural dizziness and in 62 patients without dizziness. All of them were over 64 years of age. Physical, neurological, otorhinolaryngological and ophthalmological examinations were also carried out.

Positional nystagmus was found in 31 patients of the postural dizziness group and in eight of the non-dizziness group. Only in five of these cases did the nystagmus appear in the usual sitting position (a spontaneous nystagmus of the first grade).

It was typical of positional nystagmus that the nystagmus appeared immediately after the new position had been reached, and that only a few patients had an accompanying sensation of dizziness during it.

The results indicate that the positional nystagmus of these cases had a central etiology.

It is possible that positional nystagmus which appears in the usual sitting position, or is direction-changing in its type, continuous, or vertical or diagonal in its direction, is clinically more important than are other types of positional nystagmus.

LAUTTASAARENTIE 31

From the University Eye Clinic and the Research Center for the Aged, Societas Gerontologica Fennica, Helsinki, Finland.

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LIX

## MANAGEMENT OF NON-MALIGNANT GROWTHS IN THE MAXILLARY SINUS

O. E. VAN ALYEA, M.D.

CHICAGO, ILL.

The list of non-malignant growths found in the maxillary sinus is a large one and includes the rarely encountered tumors, such as papilloma, adamantinoma, fibroma, adenoma, angioma, lymphoma, plasmocytoma, lipoma, osteoma, chondroma, neuroma and the more common types of growths, polyps and cysts.

It is my purpose in this paper to deal largely with the two growths most frequently encountered in clinical practice, namely, polyps and non-secreting or mesothelial cysts.

These growths are entities in the cause and maintenance of many cases of maxillary sinus disease, but because they have a tendency to exist quietly in the antrum producing few symptoms traceable to them, rhinologists are inclined to minimize their importance.

In not all instances, however, should the presence of these growths be dismissed so lightly. Too often the identification and elimination of an apparently inoffensive antral cyst or polyp has been followed by a cessation of symptoms which previously had resisted all diagnostic and therapeutic efforts.

During the past several months at the Research and Educational Hospitals of the University of Illinois and the Illinois Eye and Ear Infirmary, we have developed considerable interest in these growths. They have been observed in the routine x-ray examination of patients presenting symptoms referable to the maxillary sinus and occasionally have been unexpectedly revealed in films taken following the installation of iodized oil.

In a careful analysis of any large series of cases presenting symptoms suggestive of sinus involvement the influence of these growths soon becomes apparent.

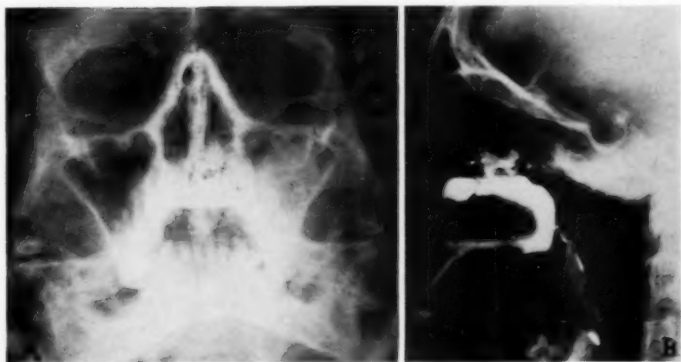


Fig. 1.—Case I. A) X-ray (Waters view) reveals a large cyst almost completely filling left maxillary sinus. B) Lateral view depicts the filling defect.

In our study they have proven to be of extreme interest because of the influence they have on maxillary sinus disease and because of the unique symptoms they cause.

#### PATHOLOGY

*Polyps.* Antral polyps may appear singly or in groups, existing as independent growths or along with generalized nasal hyperplasia or polyposis. They develop as a result of irritation of the sinus mucosa, the irritant being an allergen, a pathogen or a toxic exudate from a long-standing draining, infected sinus.

The histopathology is essentially that of edematous respiratory epithelium. A frequent site of polyp origin is the margin of the maxillary ostium, the growths developing from prolapse of an overloaded mucosa. If the prolapse is in the direction of the nasal cavity the polyp may remain in the middle meatus or, as is occasionally the case, extend to the posterior nares where it forms choanal polyp. Polyps remaining in the vicinity of the ostium, whether within the sinus or in the middle meatus, are usually a strong factor in the etiology and continuation of attacks of purulent sinusitis.

*Cysts.* Cysts common to the antrum appear on the walls singly or in multiple formation. They vary in size from a few millimeters



Fig. 2.—Case II. A) Round central filling defect left maxillary sinus caused by mesothelial cyst. B) Cyst exposed through sublabial opening before removal. 4X.

in diameter to one which expands to fill the sinus completely. The non-secreting cysts presumably of allergic origin develop in edematous sinus mucosa as distentions of the subepithelial areolar spaces and contain a clear pale or straw colored fluid.

The small mucous secreting cysts are of less clinical importance. They are, in effect, dilated glands from the sinus mucosa, the ducts of which are obstructed, probably on an inflammatory basis.

To be mentioned, but not considered in this paper are two types of odontogenic cysts, radicular and follicular. Both are of less frequent occurrence than the membranous cysts.

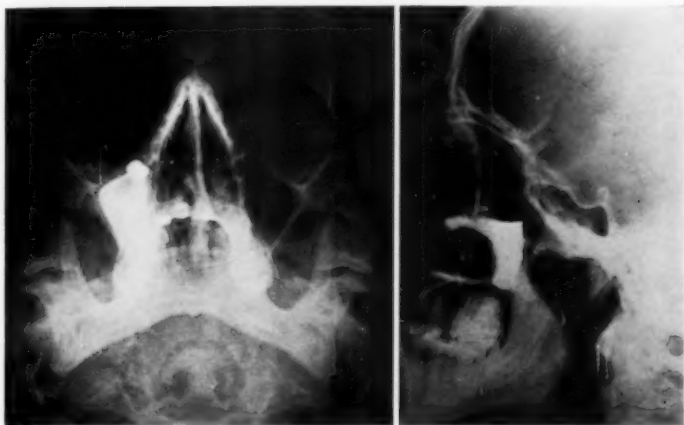


Fig. 3.—Case III. X-rays, Waters and lateral views, showing large filling defect in right antrum. At operation, this proved to be a cyst.

#### SYMPTOMS

Typical of the symptoms of antral cysts are a feeling of fullness or numbness in the cheek, with nasal blockage and frontal headache on the affected side. In many instances, however, no symptoms referable to the sinus are elicited although in some, bizarre and remote symptoms are present which may be attributable to these growths. Similar symptomatology is characteristic of antral polyps with the added one of suppuration which is present in most cases as a chronic or recurrent sinusitis.

Some of the unusual complaints which have been attributed to or at least appearing coincidental to growths in the antrum are occipital or temporal headache, serous otitis media, areosinusitis, postnasal discharge, recurrent sore throats, generalized body aches and pains, nervousness, irritability, fatigue, optic neuritis and other ocular complaints.

#### DIAGNOSIS

The presence of these growths may be determined by x-ray examination with and without the use of opaque media. Smooth



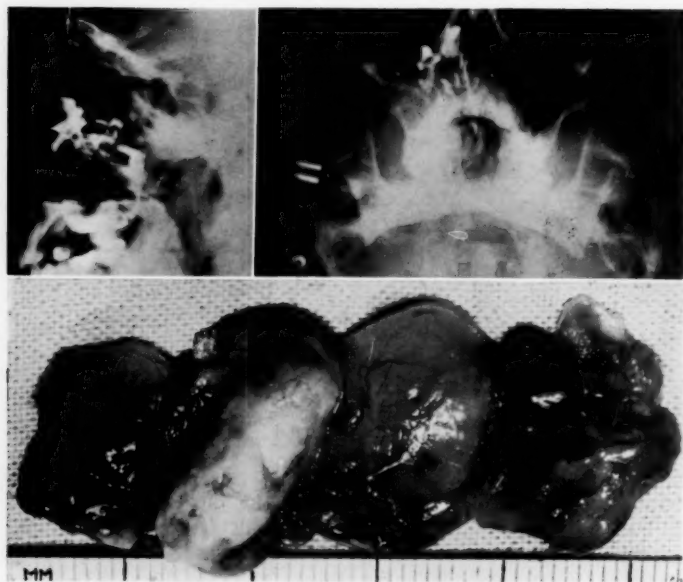


Fig. 4.—Case IV. X-rays, lateral and Waters views, right side taken with iodized oil in the right antrum showing large filling defect. Photograph showing group of 4 polyps removed from sinus.

round dome-like shadows in the floor with uniform density throughout are as a rule indicative of cyst formation. Irregular filling defects are more than likely caused by polyps, although one should always consider the possibility of other types of neoplasia, including malignancy. Smooth, thickened mucosa lining the sinus walls is significant of inflammatory sinusitis, frequently allergic in character. Cysts are not always located in the sinus floor. They may arise from any of the sinus walls and be revealed as rounded, central filling defects. In advanced cases there may be little discernible lumen in the cavity, this being occupied almost entirely by growths or thickened, edematous mucosa, or by various combinations of cysts and polyps. Cysts are less likely than polyps to be associated with sinus infection for seldom are they located near the sinus ostium, although this is a common site for the location of polyps. In cases of nasal polyposis, polyps may also be present in the antrum, this being especially true

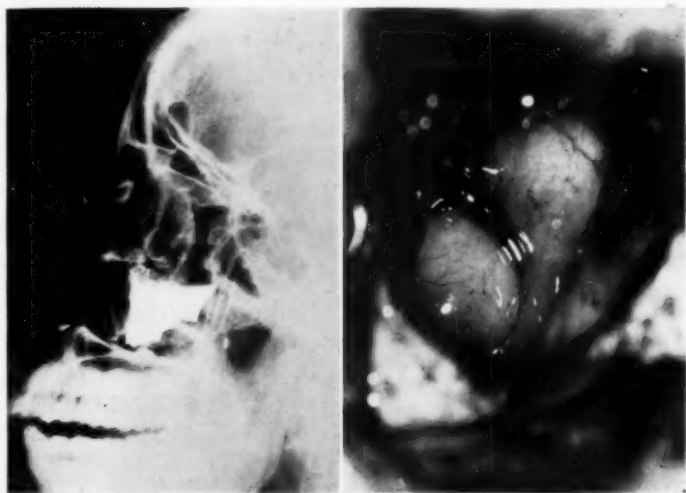


Fig. 5.—Case V. A) Lateral view showing filling defect in the right antrum caused by polyps. B) Polyps in right antrum seen through sublabial exposure. One large and two small polyps were removed. 4X.

in long-standing cases of recurrent nasal polyps when associated with suppurative sinusitis.

#### TREATMENT

**Cysts.** Cysts in the antrum should be considered as of clinical importance even though symptoms attributable to the growth are absent. When recognized, their removal should be seriously considered if for no other reason than because of the carcinogenic possibilities of all apparently innocent growths. More classical indications for removal appear as the sac reaches such proportions as to cause discomfort in the cheek or if symptoms are present near or remote which possibly could be attributed to the cyst or additionally if the sinus is associated with an inflammatory process.

The sacs are on occasions punctured at the time of sinus lavage, occurring as the antral needle penetrates the wall of the cyst. The cyst may also be reached and obliterated in the course of a nasoantral

window operation. If direct vision is deemed more desirable, a sublabial surgical approach is required.

*Polyps.* Antral polyps are accessible by way of the sublabial route. The polyps are removed with the least possible disturbance of the sinus mucosa and are routinely sectioned and studied histologically. The area of the ostium is carefully scrutinized for small growths which also are removed and the procedure is concluded with the institution of an inferior meatal naso-antral window.

Rarely is it necessary or advisable to remove portions of the sinus mucosa. Thickened membranes, even though polypoid in nature, tend to return to normal or a near normal state following antrostomy and control of allergy. Under such circumstances even polyps have been observed to disappear.

Approximately twenty cases were included in the present study. Some of these were old chronic cases which had defied all manner of treatment, others were of comparative recent origin in which the diagnosis was made on routine study.

CASE 1. G.R., white male adult. Complained of frequent head colds with sore throats, pain under the left eye of two months' duration and bilateral otalgia of several years' duration.

On x-ray a large dome-like structure was revealed which almost completely filled the left maxillary sinus (Fig. 1). On February 22, 1956, the antrum was opened through the canine fossa and a large cyst was exposed. This collapsed at the first touch and a large quantity of clear pale fluid escaped. A naso-antral window was made in the inferior meatus and the sublabial wound was closed with interrupted sutures. His symptoms disappeared following the operation and he has remained symptom free.

CASE 2. Mrs. P.E., white female, age 56. For years has suffered from an annoying recurrent sore throat with mild postnasal drip and at times she was conscious of a feeling in her left cheek. She had consulted various otolaryngologists throughout the country and had been studied from an allergic and endocrinologic standpoint. X-ray films revealed a suspicious looking round area in the left antrum. The sinus was irrigated with a negative return and iodized oil was instilled for further x-ray study. This clearly revealed a round shadow centrally located (Fig. 2). On March 10, 1956, a cyst was removed through the canine fossa. Following this the symptoms referable to the cheek disappeared but the throat symptoms remain.

CASE 3. L.B., white male, age 41. Complained of stuffiness in nose for three years with postnasal drip and pain in right cheek for the past two months.

At operation, March 6, 1956, a large bluish colored mesothelial cyst was removed from the anterior wall of the right antrum (Fig. 3). Symptoms greatly relieved since operation.

CASE 4. O.C., white male, age 26. Complained of nasal discharge from the right side for ten years. Had polypectomies in 1945 and 1953.

X-ray studies revealed large filling defect in the right antrum, which on exposure on August 12, 1955, through the canine fossa proved to be caused by a collection of four polyps (Fig. 4). A naso-antral window was inserted. The nasal discharge of many years' duration has subsided.

CASE 5. H.H., colored female. Complained of blocked nose, frequent colds, nasal discharge often.

Operation March 26, 1956, revealed three polyps on the medial wall of the right antrum near the maxillary ostium (Fig. 5). Irrigation through the window has been followed by a remission of symptoms.

#### COMMENT

In numerous instances, cases presenting symptoms referable to the maxillary sinus and many others with unusual complaints, fail of correct diagnosis because the basic cause of the difficulty, namely, benign growths in the sinus, have been overlooked or their importance minimized. In some of these, efforts have been directed toward diagnosis and treatment of the maxillary sinuses but have failed because routine films of the sinuses without the employment of contrast media revealed no filling defects and on irrigation of the sinus there was a negative return and no information was gained. In other cases, irrigation therapy and even intranasal antrostomy have failed to produce a termination of the infection. These are regarded by many writers as cases with irreversible mucosal change until a careful study results in establishing a correct diagnosis and the elimination of the antral growths.

## SUMMARY AND CONCLUSIONS

1. Antral cysts and polyps may be present themselves in the maxillary sinus and be responsible for the symptoms, yet escape recognition.

2. These growths appear more frequently than is generally recognized. They may appear as single or multiple formations. They may be present with or without nasal polyposis, and in some instances, both cysts and polyps are present.

3. These growths may be revealed on routine x-ray examination but are better delineated following instillation of an opaque medium.

4. Smooth round shadows on the floor of the sinus are as a rule indicative of cysts. Irregular filling defects are more than likely caused by polyps, although other non-malignant and malignant growths may present a similar clinical picture. Smooth, thickened mucosa lining the sinus walls is significant of allergic or inflammatory sinusitis.

5. Cysts are often eliminated by puncture at the time of sinus lavage or they may be obliterated through an intranasal antrostomy opening. Polyps are removed through a sublabial surgical approach.

6. Choanal polyps commonly arise in the maxillary sinus. Investigation of remaining neoplasia, even though the polyp and its stalk have been removed, is essential. This applies especially to cases of recurrent nasal polyps.

7. All growths recovered from the sinus should be carefully studied microscopically.

135 SOUTH LA SALLE STREET

## LX

# EXPERIMENTAL TREATMENT OF RECURRENT CARCINOMA OF THE NASOPHARYNX WITH ELECTRODESICCATION, RADIOACTIVE COBALT AND X-RAY RADIATION

FRANCIS A. SOOY, M.D.

SAN FRANCISCO, CALIF.

The work on this problem was undertaken in an effort to provide additional relief for six patients with recurrent carcinoma of the nasopharynx.

In each instance the patient had been given external x-ray radiation or reradiation to skin tolerance and the presence of recurrent carcinoma was proven by biopsy and nasopharyngeal smears.<sup>1</sup>

Intracavity radiation and electrodesiccation had been previously used in the treatment of primary tumors of the nasal septum<sup>2</sup> and from this study it was felt that a partial septectomy was a practical method of providing access to the nasopharyngeal vault both local treatment as well as to facilitate adequate follow-up inspection.

The technique used was the same in each case and consisted of:

1. *Intranasal Septectomy* (Fig. 1). Under orotracheal anesthesia the entire posterior three-fourths of the nasal septum was resected leaving only the columellar portion for support.

The margins of the defect were electrocoagulated to control local bleeding which was vigorous in some instances.

This portion of the procedure was carried out solely to obtain exposure of the tumor area in the nasopharynx.

2. *Electrodesiccation of the Tumor Area* (Fig. 2). By means of a special intranasal tip, the tumor area and adjacent mucous membrane was thoroughly electrodesiccated. Care was exercised not to

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From the Sub-Department of Oto-Laryngology, Department of Surgery, University of California Medical School.

apply the current too long at one time for fear that the sphenoid bone would conduct sufficient heat to the pituitary and optic nerve areas to cause secondary degeneration. However, at the conclusion of the procedure all the mucosa in the area should be thoroughly charred.

3. *Insertion of Radioactive Cobalt* (Fig. 3). Morrison and Low-Beer<sup>3</sup> first reported the use of radioactive cobalt<sup>60</sup> in the nasal cavity and sinuses, and it is their method which was employed.

Cobalt<sup>60</sup> which has been rendered artificially radioactive has a half life of 5.3 years, and differs only slightly in its radiologic and therapeutic characteristics from filtered radium.

The fact that it can be worked to an appropriate size and shape in its inactive state, and then "heated" or "reheated" to the desired degree of radioactivity is a significant advantage.

The Foley urethral catheter is an excellent retainer since the bag can be distended with a radiopaque solution (diodrast) and it is then possible by means of x-ray films to measure the exact distance between the head and the surrounding tissue. This permits an accurate calculation of depth dosage. The bag further serves to maintain the cobalt at the correct distance from the tissue to assure uniform radiation.

The catheter is held in position by means of anterior and posterior nasal packing.

Radioactive cobalt emits almost pure gamma radiation and the treatment time was calibrated so that the patient received 4000 to 6000 gamma roentgens at one centimeter distance divided in two applications one week apart.

The use of additional radiation in an area which has already been heavily radiated was approached with some caution. However, the tolerance of the nasopharynx to radiation can be enormous, e.g., Case 5 in which the patient was subjected to 36,000 roentgen and 1,400 milligram hours of radium to the nasopharynx over a four year period with no lasting harmful effect to his nasopharynx, or unfortunately, his tumor.

Postoperatively there is initially considerable crusting and local radiation mucositis in the nose. This gradually subsides after 6 to 8 weeks and the nasopharynx begins to assume a normal appearance except for local small areas of sequestering bone principally in the anterior sphenoid and posterior ethmoid area.



This process may produce a chronically granulating area which is easily confused with recurrent tumor. The nasopharyngeal smear has been of considerable help in differentiating these lesions.

The patient should be entirely comfortable after the first two months but may require several months for complete separation of the necrotic bone.

Follow-up examinations were made at monthly intervals for the first year and then once every three months after this.

#### RESULTS

All six patients were considered to be hopeless prior to carrying out the procedure.

Three of these patients are well and have been entirely free from any evidence of recurrence for periods of eight years, six years nine months, and six years after the procedure.

One patient died eight months after the procedure from extension of her cervical metastasis. There was no evidence of nasopharyngeal tumor at the time of death. The other two expired within 13 months of their procedure.

Both of these cases had early x-ray evidence of involvement of the base of the skull.

In Case 1 a radium plaque was used instead of cobalt for technical reasons.

We have subsequently accumulated ten additional patients where this method has been applied and of these five are dead while five are living and well for periods varying from six months to four years.

In some of these cases this method of treatment was carried out as the primary treatment but always in combination with external x-ray radiation.

The over-all results can be summarized as follows:

|             | DIED | LIVING |
|-------------|------|--------|
| 0-6 months  | 2    | 1      |
| 6-12 months | 2    |        |
| 1-2 years   | 4    | 1      |
| 2-3 years   |      | 2      |
| 3-5 years   |      | 1      |
| 5-8 years   |      | 3      |

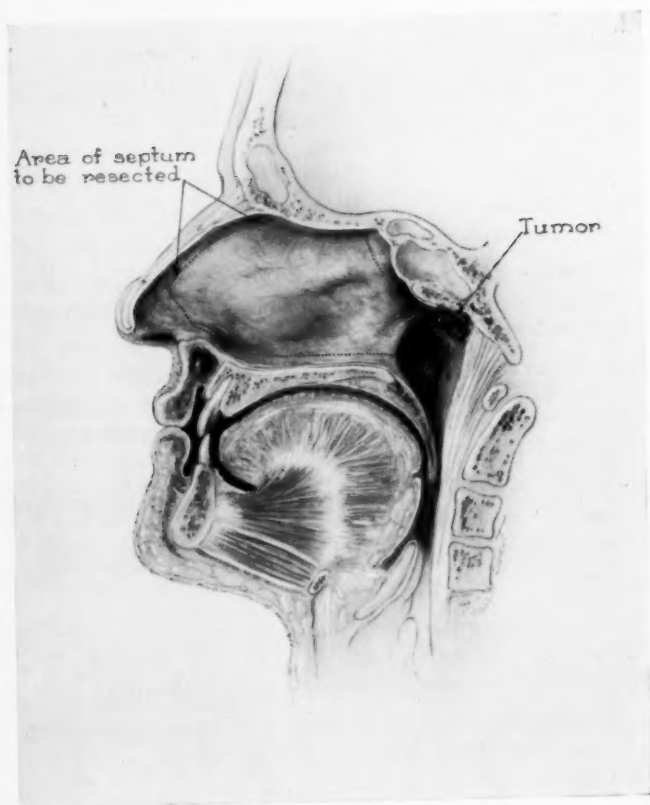


Fig. 1

## COMMENT

Since the series of cases presented is so small it was hoped that a longer follow-up might help evaluate the results.

It is felt at the present time that intensive external x-ray radiation is still the treatment of choice but that there are very useful adjuncts to this therapy and these include:

1. Intranasal radiation with either radium or radioactive cobalt in dosages approximating 6000 r at 1 cm distance. This should be done in every case.

2. Electrodesiccation can be effectively used in this condition as evidenced by Case 3 in which there was proven recurrence after external radiation and cobalt radiation which was controlled by thorough fulguration of the nasopharyngeal lesion and has remained under control for six years.

3. Septectomy is indicated only when the primary tumor is large and local removal combined with fulguration is desired or when no further local or external radiation can be given and electrodesiccation is used in the hope of bringing the tumor under control.

*Complications.* Initially it was feared that a severe atrophic rhinitis and ozenae would result from the procedure but this has not been the case and the patients are quite comfortable with steam inhalations during dry weather.

We have, however, been troubled by a persistent dry adhesive otitis media in two cases and one (Case 3) will soon require a hearing aid to continue working.

In one patient of this series and two others a unilateral prophylactic neck dissection was carried out by the referring surgeon in spite of the absence of any palpable nodes on the side of the lesion. In each specimen microscopic metastases were present. Clinical or x-ray evidence of extension of the primary tumor to the base of the skull or to the brain precludes successful therapy in our cases.

Eustachian congestion which persists and particularly serous otitis in a Chinese patient should be regarded with the utmost suspicion.

In three cases an early diagnosis of carcinoma of the nasopharynx was made by means of a prophylactic biopsy into what appeared to

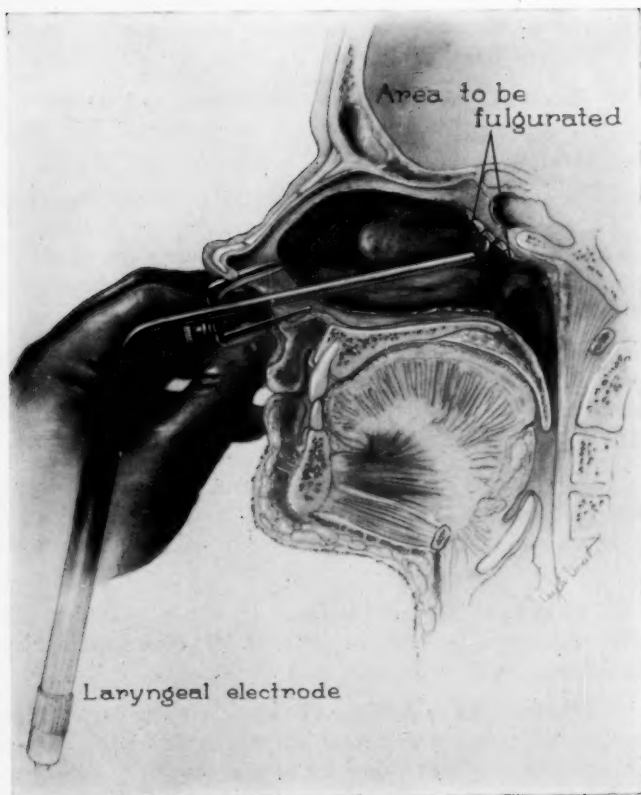


Fig. 2

be a completely normal nasopharynx, when the eustachian symptoms did not respond to adequate therapy.

#### SUMMARY

1. An additional treatment of carcinoma of the nasopharynx is described. This consists of:

- A. Intranasal septal resection.
- B. Intranasal electrodesiccation of the tumor area.
- C. Local intranasal radiation with radioactive cobalt.

2. Initial studies indicate that 50 per cent of the patients were benefited. A larger series of cases with a prolonged follow-up is necessary before any valid conclusions can be drawn.

3. The procedure seems to have little effect when the tumor involves the base of the skull.

4. Six illustrative cases are presented.

#### REPORT OF CASES

CASE 1.—E.M.H. This white male druggist aged 59 was first seen at the University of California Hospital Out-Patient Department on October 12, 1945, complaining of left nasal obstruction, bleeding and left fronto-occipital headache.

Examination revealed a large, fungating mass in the left nasopharynx involving the base of the septum.

Subsequent investigation revealed he had undergone a biopsy two years and four months previously which showed: "Anaplastic carcinoma, grade IV."

This was treated with "radium applications" and his symptoms subsided.

Four months later he received 600 mg hours contact radium therapy for a recurrence.

Rebiopsy two years and four months after his initial diagnosis showed no malignancy; however, his symptoms continued and one year and nine months later he received an additional 1250 r of 200 kv x-radiation to his left posterior nasal area.

The patient did not appear again until March 10, 1948, four years and nine months after his initial diagnosis, at which time he again suffered from left nasal obstruction, bleeding and headache. Biopsy at this time revealed "transitional cell carcinoma of the nasopharynx," and nasopharyngeal smears were also positive.

Two months later a cautery resection of the entire three-fourths of the nasal septum was carried out under general anesthesia and the tumor site fulgurated with

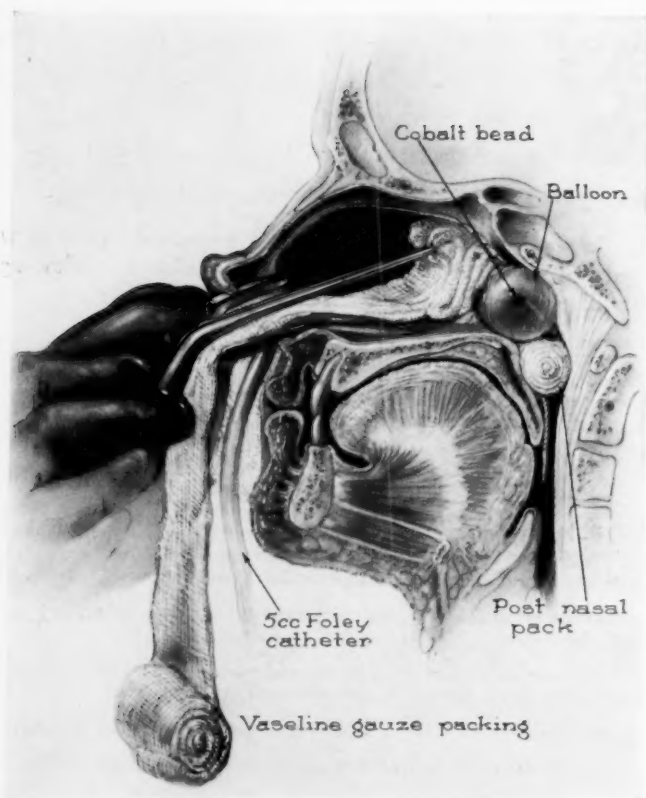


Fig. 3

the bovie unit. Following this procedure the nasopharyngeal smears became negative but his severe headache persisted, and two months postoperatively malignant cells were again found in his smears.

He was again admitted and more complete cauterization of the nasopharynx was carried out under general anesthesia. Preliminary biopsy failed to reveal any malignancy.

He again remained comfortable for two months when he noticed a recurrence of bleeding and pain and malignant cells were found in his smears.

He was again admitted and under general anesthesia a radium plaque consisting of four 10 mg needles was inserted over the tumor area at the base of the septum and held in position by anterior and posterior nasal packing. He received a dosage of 1020 mg hours.

Following this treatment his headache entirely disappeared and no further malignant cells have been found in his smears to the present time, eight years after his last treatment.

There is a slight crusting of the nasal mucosa in dry weather which is controlled by steam inhalations and he did not have any difficulty with a mild diabetes mellitus during his many procedures.

No cervical nodes have been demonstrated at any time and repeated skull and sinus x-rays failed to show evidence of bone invasion at the base of the skull.

This patient subsequently developed a pea sized new squamous carcinoma of the nasal vestibule which was resected locally and not connected with his original lesion.

CASE 2.—J.G.R., a 52 year old Portugese trucker, was first seen at the University of California Hospital Out-Patient Department on March 5, 1948, complaining of progressive right nasal obstruction, occasional bleeding and foul discharge of two years' duration.

Examination revealed a large, fungating mass filling the right nasopharynx and involving the base of the nasal septum. The lesion was biopsied and reported as "lymphoepithelioma of nasopharynx." Nasopharyngeal smears also showed malignant cells.

He was then given a full course of external radiation to his nasopharynx to a total tumor dose of 4000 r.

No cervical adenopathy was present.

The patient remained well and his smears were negative until July 29, 1949, when the mass in his nose recurred and his smears were again positive, one year and four months after his initial treatment.

He was admitted to the hospital and under general anesthesia the recurrence was biopsied, found to be positive, and the lesion thoroughly fulgurated with the bovie unit intranasally. Following this a 6 mm radioactive cobalt<sup>60</sup> bead in a Foley catheter was placed in the right side of the nasopharynx and packed in position. A total of 5000 gamma roentgens were administered at 1 cm distance over 58 hours.

On October 19, 1939, three months later, a recurrence was noted in the vault of the nasopharynx on the right side. Both smear and biopsy were positive.



The patient was re-admitted and the entire posterior three-fourths of the nasal septum was resected under general anesthesia and the tumor site thoroughly cauterized with the bovie unit.

Three months later he was clinically well but his nasopharyngeal smears showed evidence of malignant cells.

He was re-admitted and radioactive cobalt<sup>60</sup> was again applied in a Foley catheter to the nasopharynx for a total dosage of 4000 gamma roentgens at 1 cm over 31 hours.

Since this treatment he has remained clinically and cytologically well to the present time, some six and one-half years after his last treatment and over seven years after his initial diagnosis.

He has only a minimal crusting in his nose and does not feel that it is bad enough to require steam inhalations or douches.

Repeated x-ray examination of the base of the skull failed to reveal any evidence of bone involvement.

A 1 cm area of necrotic bone over the anterior face of the right sphenoid was finally extruded leaving the sphenoid sinus open.

**CASE 3.—P.Q.** This 35 year old Chinese housewife was first seen on August 8, 1949, complaining of a large cervical node of several weeks' duration.

Examination revealed a small pea sized mass in Rosenmueller's fossa on the right side of the nasopharynx. There was a single large, hard node in the middle of the right posterior cervical chain. Biopsy from the nasopharynx showed a "transitional cell carcinoma." Nasopharyngeal smears were positive.

X-ray examination of the chest revealed no metastasis and x-rays of the base of the skull were normal.

X-ray treatment was given to the nasopharynx and neck area for a total tumor dose of 4700 r.

She remained clinically well for seven months at which time her nasopharyngeal smears again became positive. A rebiopsy again revealed lymphoepithelioma of the nasopharynx.

On April 8, 1950, under general anesthesia, the entire posterior three-fourths of the nasal septum was resected intranasally and the edges cauterized.

The tumor site was thoroughly desiccated and a radioactive cobalt<sup>60</sup> bead in a Foley catheter was packed in place in the right nasopharynx.

A total of 6000 gamma roentgens was administered at 1 cm distance over 45 hours.

Postoperatively there was considerable crusting for eight weeks at which time the nasopharynx was well epithelized except for a small area of exuberant granulation tissue which was further cauterized under general anesthesia.

There was subsequent sequestration of the anterior face of the right sphenoid and the nasal wall of the large right posterior ethmoid cell leaving these sinuses widely open.

Repeated nasopharyngeal smears and biopsies at three month intervals have failed to reveal any evidence of recurrence.

The patient is almost entirely free of nasal crusting and there has been no evidence of recurrence of her cervical nodes to date, six years after her last treatment and six years and nine months after the initial diagnosis was made.

**CASE 4.—O.B.Y.** This 39 year old white female was first seen at the University of California Hospital on August 11, 1949, complaining of a mass in the left side of her neck and stuffiness in the left ear and left nostril of two months' duration.

Examination revealed a chain of large, hard, fixed nodes along the left sterno-mastoid muscle, fluid behind the left drum, and a large, fungating mass in the left nasopharynx. This was biopsied and reported as lymphoepithelioma of the nasopharynx. Her chest x-ray was clear.

She was given a full course of external x-radiation to her neck and nasopharynx. The total tumor dosage was 4187 r.

This treatment was tolerated poorly and she was given supportive therapy in the hospital for two and one-half weeks.

She was subjectively improved but her smears remained positive consistently and a small amount of tumor could be visualized high in the nasopharynx.

She was re-admitted four months after her radiation and under general anesthesia the entire posterior three-fourths of the nasal septum was resected intranasally and the margins cauterized. The tumor site was thoroughly cauterized and a cobalt<sup>60</sup> bead in a Foley catheter was inserted and packed in place in the nasopharynx. A total of 4000 gamma roentgens were delivered at 1 cm over 31 hours.

Following this she developed considerable crusting in the nasopharynx and several small sequestra were sloughed out. Three months later she developed a cellulitis in her right neck and subsequent biopsy of this area revealed metastatic carcinoma.

Her last nasopharyngeal smear was negative but she continued to develop more tumor in her neck and after a downhill course, expired some eight months after her last treatment, and 13 months after her initial biopsy.

Repeated x-ray examinations of the base of her skull failed to reveal any evidence of bone involvement.

**CASE 5.—H.C.W.** This 41 year old Chinese male was first seen in the University of California Hospital Out-Patient Department on March 27, 1950, complaining of recurrent nasal bleeding, obstruction, decreased hearing and a numbness of his right cheek of two months' duration.

Investigation revealed he had received the following treatment for a microscopic diagnosis of "lymphoepithelioma of the nasopharynx."

February 1946—5100 r to nasopharynx.

February 1946—1200 mg hours of radium locally to the nasopharynx.

December 1946—Lesion recurred and he was given 3200 r to the nasopharynx.

January 1947—200 mg hours of radium locally to nasopharynx.

October 1947—Biopsy again positive and patient received 5400 r additional x-radiation to nasopharynx.

March 1948—Recurred again and 3600 r of x-radiation were given through and intraoral cone and 3780 r externally to the nasopharynx.

August 1948—Again recurred and 6000 r were given through three neck fields to the nasopharynx.

September 1948—3172 r were given intraorally.

July 1949—1200 r were given to base of skull for severe pain.

Initial examination revealed a large, flat, bleeding mass occupying the right nasopharynx. There was partial ankylosis of the jaw and marked skin changes from radiation. No cervical nodes were felt. Biopsy revealed "transitional cell carcinoma—nasopharynx," and the smears were positive. Chest x-rays showed no metastases but x-rays of the base of the skull revealed some asymmetry but no definite invasion. The patient is a known diabetic.

The patient was hospitalized for a severe spontaneous nasal hemorrhage which subsided after postnasal packing and antibiotic therapy.

He was re-admitted and under general anesthesia on June 5, 1950, an intranasal resection of the posterior three-fourths of the nasal septum was carried out and the margins cauterized. The tumor area was thoroughly desiccated and a radioactive cobalt<sup>60</sup> bead in a Foley catheter was inserted into the nasopharynx and fixed in place with packing. 500 cc of whole blood was given on the table because of the profuse bleeding encountered.

A total of 6000 gamma roentgens were administered over a treatment period of 51 hours at 1 cm distance.

Postoperatively he developed the usual crusting and required additional antibiotic therapy because of his diabetes.

A complaint of blurring of vision was attributed to his marked diabetic retinopathy.

Additional skull x-rays a month later now revealed evidence of destruction of the base of the skull on the right side.

Two months later biopsy of a cervical lymph node on the right side revealed no tumor.

One month later his nasopharyngeal smears and biopsy were again positive.

His course from this point was steadily downhill, but the time of his expiration was not obtained.

CASE 6.—B.L. This 48 year old Korean male was first seen in July 1950 with evidence of recurrent carcinoma around the right eustachean orifice.

Investigation revealed that he had been seen two years previously at which time he complained of glands in the right side of his neck of one and one-half years' duration. No primary lesion could be found but biopsy of his cervical nodes revealed "lymphoepithelioma."

He was given external x-ray treatment until a tumor dose of 4500 roentgens was reached and was well until August 1949 when he showed evidence of a mass in the right side of his nasopharynx. An additional 4355 roentgens was given partly intraorally to the nasopharynx.

He was free of further symptoms until July 1950, some ten months later, when he again developed a mass in the right side of the nasopharynx and was referred for septal resection and cobalt irradiation.

Chest x-rays revealed no evidence of metastasis and skull films showed the petrous bone to be intact.

On direct examination of the nasopharynx there was a small nodular mass in the area of the right eustachean orifice which partly occluded the tubal orifice.

The right middle ear contained dark fluid and the drum was retracted.

The skin on the right side of the neck showed some radiation telangectasia but no nodes were palpable.

Biopsy of the right tubal area revealed "transitional cell carcinoma, nasopharynx."

On July 13, 1950, the entire posterior three-fourths of the nasal septum was resected intranasally and the margins cauterized. The tumor site was thoroughly fulgurated and a bead of radioactive cobalt<sup>60</sup> in a Foley catheter was packed in place in the nasopharynx and a total of 8000 gamma roentgens was administered over a period of 35 hours at 1 cm depth.

Postoperatively he did poorly with continued right V nerve pain.

Three months later his nasopharyngeal smear was again positive and examination of skull x-rays showed evidence of definite extension into the petrous area.

Minimal crusting was present in his nose but the tumor site again showed evidence of activity.

He expired 14 months after his septal resection, after receiving one of the experimental cancerocidal chemicals with some subjective alleviation of his symptoms.

Biopsy of an ear polyp on the right side showed carcinoma.

#### 490 POST ST.

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I am deeply grateful to Drs. Lewis F. Morrison and the late Bertram V. A. Low-Beer for the privilege of using radioactive cobalt in these cases.

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## LXI

### ON CIGARETTE SMOKING, BRONCHIAL CARCINOMA AND CILIARY ACTION

#### IV. CILIARY STREAMING THROUGH THE LARYNX AND DISTRIBUTION OF LARYNGEAL EPITHELIUM

A. C. HILDING, M.D.

DULUTH, MINN.

Recently I have been exploring the possibility of the relation between ciliary action and carcinoma of the respiratory tract.<sup>1,2</sup> This involves a series of studies, one of which, of necessity, is the mapping of the ciliary streaming through the larynx. When first planned, it seemed simple enough. It seemed sufficient to put some indicator on living ciliated epithelium in the larynx and then sit back and record what happened. Unfortunately, it proved not to be so simple. Many unexpected difficulties arose, hence the study has not been completed and this must be in the nature of a progress report.

Closely related to the matter of ciliary streaming, of course, is the distribution of ciliated columnar and squamous epithelium within the larynx. It seemed desirable to study this facet of the subject as well.

A search of the literature failed to reveal any description of ciliary streaming through the larynx.

A number of good descriptions of the distribution of epithelium in the larynx were found. Low-Beer and Morrison<sup>3</sup> have written one and Hopp<sup>4</sup> another. Hopp found that the true cords are covered with stratified squamous epithelium, which has small papillae. This squamous epithelium is predetermined before birth. During the first year of life, the ventricular folds also become covered with squamous

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From the Research Laboratory, St. Luke's Hospital, Duluth 11, Minnesota. Work supported by grants from the Louis W. and Maud Hill Family Foundation of St. Paul, the Edward C. Congdon Memorial Trust, Miss Elisabeth Congdon and The Women's Service Guild of St. Luke's Hospital.

epithelium. The interarytenoid area is lined with squamous epithelium but he states that, although there are occasional islands of squamous epithelium in the adult larynx, he believes these are rare. The margin of the epiglottis is also covered by squamous epithelium; otherwise by and large the larynx is lined with ciliated columnar epithelium.

#### MATERIAL FOR STUDY

The material used for the study of the distribution of epithelium consisted of five human larynges removed at autopsy. For the study of ciliary streaming forty-three calves' larynges were used. These were obtained on the killing floor at a packing plant very soon after death. Most of them were brought to the laboratory, but some were used right at the packing plant.

#### STUDY: DISTRIBUTION OF LARYNGEAL EPITHELIUM

Of the five human larynges studied for the distribution of the epithelium, the best preparations were obtained from two men, one 61 and the other 81 years of age. The interior surfaces of both of these larynges were stained with one per cent methylene blue and studied under a Greenough dissecting microscope by means of reflected light.

The study on the 61 year old man yielded these findings: The squamous and ciliated cells were fairly well stained and readily differentiated. The line of transition from the columnar ciliated epithelium of the subglottic area and the squamous epithelium on the cord was a very sharp one and followed along the margin of the cord. No squamous cells were found below this line. Following this line of squamous epithelium anteriorly it was found to be continuous until the anterior commissure was reached. There, in the anterior commissure, directly in the midline, it was interrupted by a thin line of ciliated columnar cells extending from the subglottic area below the cords to the ciliated regions in the vestibule. So, anteriorly, in this specimen there was continuous columnar ciliated epithelium in the bronchial tree through to the anterior commissure, upward between the cords to the ciliated epithelium on the vallecula of the epiglottis. Going posteriorly, the line of squamous epithelium continued as far as the arytenoids. The area over the arytenoids was mixed but mostly squamous. The interarytenoid area contained both types of epithelium; the lining was folded into ridges, the tops of which tended to be squamous while the valleys between were ciliated columnar. The ventricle was found to be lined by ciliated columnar epithelium.

The larynx from the 81 year old man proved to be somewhat different. This larynx was split a little to one side of the midline anteriorly and posteriorly and the halves stained and laid out for examination. As in the previous specimen, all of the cells below the line of squamous epithelium on the cords down through the subglottic area into the trachea were of the columnar ciliated type. Many glands were seen in this region just below the cords and they seemed to be arranged more or less in parallel curving lines, directed upward and backward toward the interarytenoid area. Squamous cells were found to begin on the margin of the cords along a very sharp line running parallel with the axis of the cords. In this instance, this line of squamous epithelium extended all the way to the midline anteriorly. There were no ciliated cells going through the commissure. It extended also to the process of the arytenoid cartilage posteriorly and across this into the interarytenoid space to the midline. Again posteriorly, I could trace no ciliated cells continuously all the way from the subglottic to the supraglottic region. There may have been some where the scissors crushed the epithelium. In studying the folds in the interarytenoid area, it was found that some were squamous on the ridges and ciliated in the valleys. Some, on the other hand, were found to have the reverse arrangement. (It may be that the normal premortem folds were distorted and shifted during the dissection.) Excepting for that portion formed by the superior surface of the true cord, the ventricle was lined entirely by columnar ciliated epithelium. The squamous band extended from the margin of the cord a little distance over the upper surface toward the ventricle. The inferior aspect or margin of the false cord also was covered with squamous epithelium. Most of the medial and upper surface of the false cord was found to be ciliated, as was the area above the false cord in the anterior portion of the larynx, until, going outward, it became squamous at the aryepiglottic fold. Toward the posterior end of the false cord, there were many islands and peninsulas of squamous epithelium surrounded more or less completely by columnar ciliated epithelium. As stated, squamous epithelium was encountered on the aryepiglottic folds but even much of this region was ciliated. The epithelium over the arytenoids contained a mixture of squamous cells and ciliated cells. The epiglottis on its laryngeal surface was very largely ciliated with squamous epithelium on the margin.

In a word, the distribution of epithelium, as found in these studies, agreed well with that which is commonly accepted, with the



exception that above the cords the squamous epithelium was not sharply outlined. There were numerous islands and peninsulas of squamous epithelium which were surrounded by ciliated epithelium and also there were numerous folds, the tops of which tended to be squamous epithelium and the depths ciliated. As the aryepiglottic folds and the margins of the epiglottis were approached, an irregular mixture of squamous and columnar epithelium was found. On the very margin of both, it was all squamous.

In these specimens, it was found that there were threads of mucus protruding from the mouths of the glandular ducts. When these threads had been divided from the mucous blanket, they retracted forming small, globular or mushroom-like masses at the opening of the glandular ducts. When they still remained attached to the mucous blanket, they stretched out for considerable distances and were seen in other specimens to act like anchors for the mucous blanket, holding it stationary against the pressure of the cilia. The significance of this will be mentioned later.

#### ANIMAL EXPERIMENTS: CILIARY STREAMING THROUGH LARYNX

Most of the tests of ciliary action were made in the larynges of calves as soon after death as it was possible to get the specimens. India ink was used to make the ciliary streaming visible; small drops were placed on the mucosa at the level of the upper trachea or lower larynx. The specimen was then placed upright and progress of the ink through the subglottic area to the cords and into the upper larynx was observed. Great difficulty was encountered in obtaining adequate ciliary streaming. It was first thought that the specimens became too cold, so they were placed in an incubator in which the air was well laden with moisture, but this did not remedy the difficulty. Then, to shorten the time-lapse after death, experiments were carried out at the packing plant, but the results were disappointing. There was some flow but nothing to compare with that which is commonly found in the trachea. Three different types of insulated containers, providing warm, moisture-laden air, were used but did not solve the problem. It was then discovered that by placing portions of the bronchial tree in plastic bags and leaving them at room temperature, the cilia would continue beating for upwards of 36 hours without any special attention. This was tried on the larynges with only a measure of success. Despite these difficulties, some fairly satisfactory observations were made. From the 43 specimens, enough information was

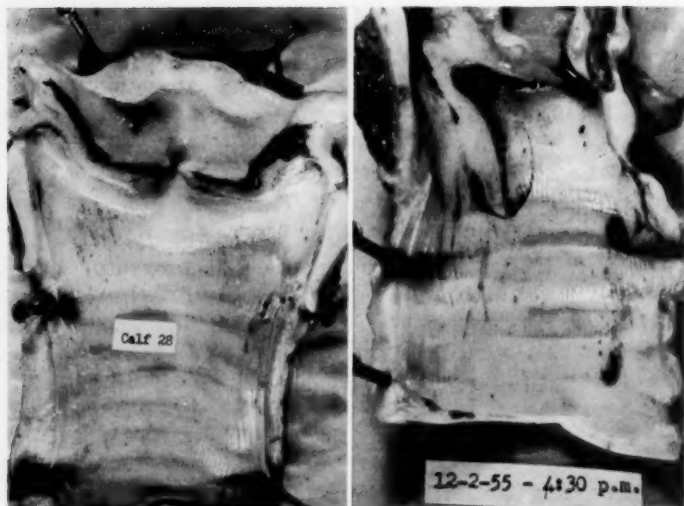


Fig. 1.—Larynx split in the midline posteriorly and spread open. The ciliary flow posteriorly along the cords from the anterior commissure is clearly indicated by the distribution of the ink.

Fig. 2.—One-half of a calf's larynx showing the ciliary streaming in the subglottic area. On the lateral wall, it passes backward and upward in a smooth curve to the interarytenoid space.

gleaned so that a general idea was obtained of ciliary drainage through the larynx. In some, the progress of flow could be followed from the trachea to the pharynx although it was sluggish (Figs. 1 and 2).

Drainage through the larynx in these animals actually begins down at the bifurcation where the streaming from the right and left main bronchi comes together at the coryna. On the coryna, about at the middle, the streams from the medial halves of both the main bronchi divide and pass anteriorly and posteriorly, making two main streams in the trachea, one on the anterior surface and one on the posterior (Fig. 3). It does spread out somewhat before reaching the larynx, but, in general, these two main streams seem to be maintained. The stream along the posterior tracheal wall passes directly up into the interarytenoid space and up to the edge of the larynx where, in

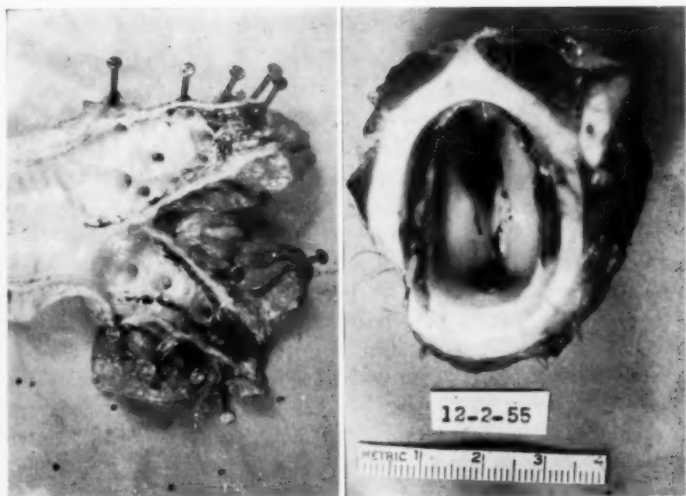


Fig. 3.—Bifurcation of a cow's trachea with India ink indicating the two main streams of flow on the anterior and posterior walls of the trachea and how they are formed at the coryna.

Fig. 4.—Calf larynx seen from below with India ink marking the flow on the inferior surface of the cords. Anteriorly (below) there is a pool at the anterior commissure from which the ink streams backward (up) into the interarytenoid space.

the living state, it undoubtedly is carried over into the pharynx and thus down into the gastro-intestinal tract. The stream on the anterior wall passes up through the trachea and through the lower subglottic region until it approaches the cords. Here a portion of it bends posteriorly, in more or less of an even arc, to the arytenoids and over the arytenoids and out into the interarytenoid space. The very central portion passes directly upward until it reaches the margin of the cords and the anterior commissure. A little pool tends to form at the anterior commissure, the rest turns and follows the margins of the cords posteriorly—some on each cord (Fig. 4) to the arytenoid and thence over the arytenoid, up to the interarytenoid margin of the larynx. In some specimens, the ink did not reach the anterior commissure or the anterior third of the cords. Instead, it described a

circle surrounding these parts, as though a blob of mucus had come from above and passed between the anterior extremities of the cords and through the anterior commissure to the under side of the cords. If the anatomy of the ventricle is the same as in man, such a discharge of mucus could have come from the sacculus.<sup>5</sup>

#### DIRECTION OF BEAT OF CILIA

Attempts were made to determine the direction of the beat of the cilia. As the cord is approached, the ciliary stream turns and passes backward. There seems to be little doubt but that the cilia of the trachea generally beat in the axis of the trachea. The question arises, do they keep beating directly upward as they approach the cords or do the cilia on the cords just inferior to the margin beat at right angles, toward the posterior portion of the larynx? I have watched the cilia in action and have tried several experiments to establish this point but so far have not succeeded in determining if the direction of beat just below the margin of the cords is different from that in the subglottic region or in the trachea.

#### COMMENT

The distribution of epithelium in the few human specimens obtained was found to correspond closely with that which is generally accepted, except that above the cords the pattern of squamous epithelium was varied and inconstant. The whole of the margin of the cord was found to be covered with squamous epithelium as was the anterior portion of the false cord and the rim of the epiglottis and the very edge of the aryepiglottic fold. The arytenoid area and the interarytenoid area, the posterior half of the false vocal cord and the lateral portions of the upper larynx contained a mixture of squamous and ciliated epithelium. There were numerous squamous islands and peninsulas. In one of the specimens examined (an 81 year old man), squamous epithelium seemed to extend entirely around the glottis, i.e., on both vocal cords, across the anterior commissure and over the arytenoids and across the posterior commissure. (How was mucus drainage accomplished in this man? Perhaps he had difficulty. Some elderly people must "clear the throat" very frequently.) There was ciliated columnar epithelium both below and above this ring; there did not seem to be any continuity through from that in the subglottic area and that above the cords. In one specimen continuous ciliated columnar epithelium was found to con-

nect the ciliated epithelium above and below the cords both through the anterior commissure and in the interarytenoid area—although that through the anterior consisted only of a very thin line.

It is difficult to demonstrate ciliary streaming well in the larynges of newly killed calves. The reason is not entirely clear. Stomach content is frequently seen in the larynges and, since acid tends to stop ciliary action, it was thought this might be the reason it was so difficult to demonstrate it and undoubtedly this is one factor. But, obviously, there is something else that has nothing to do with this or with drying from evaporation or with cooling. Many times it was noted that the ciliary action was vigorous but that the mucous blanket did not move. In several specimens, it was noted that fragments of the mucous blanket were sometimes held stationary by long strands of thread-like mucus which came out of the mouths of the glands and acted like anchor ropes. A probable explanation of this difficulty might lie in cessation of secretion of viscid mucus by the glands soon after the time when circulation ceases. It is quite possible that that mucus which at the moment is being produced in the cells fails to be completely extruded and remains attached within the gland. Since it extends through the duct into the lumen and is attached to the underside of the mucous blanket, it could act as an anchor. If enough such anchors are present, the mucous blanket could remain stationary even though the cilia beat vigorously beneath.

Be that as it may, a fair idea has been obtained as to the course of ciliary streaming from the trachea through the larynx. The ciliary streams flowing upward from the main bronchi are divided at the coryna in such manner that there is a special concentration along the anterior and posterior walls of the trachea. The flow in the trachea is usually more or less vertical. As the streams approach the larynx, those on the posterior wall ascend vertically between the arytenoids to the posterior margin of the larynx; those in the anterior portion of the trachea ascend vertically until they approach the vocal cords, then the most lateral deviate, passing obliquely upward and posteriorly, cross the arytenoids, thence course into the interarytenoid space to the upper margin of the larynx. The central portion of the heavy anterior stream flows directly to the margin of the cords, then turns posteriorly and follows the cords back to the arytenoid and thence out with the other stream. At the anterior commissure, the mucous blanket must divide. This means that at one point or line just at the commissure, movement would come to a standstill as the blanket is torn asunder

to pass in two opposite directions. How much the blanket is slowed up in the anterior part of the cords as it continues to tear is probably variable. The slowing would depend a great deal upon the viscosity of the blanket. If the viscosity were low, there might be almost no change in the velocity of flow; if the viscosity were high, the velocity might be sharply reduced until the blanket had been torn apart and no longer offered a pull across the midline.

It is important to know if the direction of ciliary beat alters as well as the direction of flow. This I have been unable to determine as yet. It may be that the cilia beat parallel with the axis of the trachea all the way up to the very margin of the cord, where squamous epithelium is encountered. In that case, the change of direction of the flow of the mucous blanket would be due to the traction of the cilia in the posterior part of the larynx. One of the experiments I tried would seem to indicate that this is the case. Traction from the ciliated surfaces farther back is surely a factor but, if this is the main force, I do not know. It could be that the ciliary beat on the under surface of the cords is in an anteroposterior direction. If this is the case, the dynamics of the ciliary streaming in this portion of the larynx would be very different than if the ciliary beat continues to be in the axis of the trachea. Further experiments are under way to determine this point. In none of the specimens was there any streaming across the cords. I have no doubt that under certain circumstances this could happen but these experiments would seem to indicate that it is not the usual manner of drainage.

In a number of specimens, a little pool of mucus was found, before any testing was done, right at the anterior commissure and, in these, the ciliary streaming from the trachea did not quite reach the anterior portion of the cord. The source of this mucus is not known. It could have been from the ventricular sacculi or it could have been from mucus previously carried up from the trachea and left more or less stagnant at this point.

#### RELATION OF CILIARY STREAMING TO CARCINOMA

Could ciliary streaming have anything to do with carcinoma, either as to genesis or distribution? Two possibilities suggest themselves:

- 1) If carcinogenic substances (be they from cigarette tar, black-top highways, gasoline, mine dust or of whatever nature) which

have been inhaled and deposited on the mucous blanket cause cancer in the larynx,<sup>6</sup> it would likely occur first where the application of the substance to the epithelium is longest and most intimate. These experiments would indicate that that region would be at the anterior commissure and the anterior portion of the cords where the mucous blanket comes to a standstill, divides and passes backward along the two cords. From all the information I have been able to glean from laryngologists, it would seem that 80 to 85 per cent of all of the carcinomas occurring in the larynx occur on the cords and the majority of these occur on the anterior portion or right at the anterior commissure. It is possible that the characteristics of the ciliary streaming in this area might account for this distribution of carcinoma. On the other hand, one could not so conclude on present evidence. There are other factors also to be considered, such as the impact of air on the upper surface of the cords, air eddies, as well as a comparatively large amount of mucus which is discharged from the ventricle over the anterior portion of the cords.

2) Another relation of ciliary streaming to the distribution of carcinoma might lie in the field of transplant. Ormerod<sup>7</sup> and Bryan<sup>8</sup> have both pointed out that carcinoma cells are easily knocked loose from the surface of carcinoma in the larynx. These undoubtedly spread through the larynx and trachea. What becomes of them? In the nose, desquamated epithelial cells pass with the secretion back into the pharynx and into the gastro-intestinal tract. Might not the same be true in the larynx, that carcinoma cells are carried away on the mucous blanket in the mucous stream and taken down into the stomach where they may be destroyed? Another point suggesting this is the statement by Ormerod that recurrences following laryngectomy are very apt to be found just below the tracheotomy opening. A tracheotomy opening would act as an obstruction in the ciliary stream along the anterior wall of the trachea and it could be that detached cancer cells are carried to this point and deposited in such manner that they become transplanted and grow.

#### CONCLUSIONS

The distribution of squamous epithelium within the larynx as found in the specimens studied corresponds closely to that which is commonly accepted, with the exception that above the cords it is apt, in certain areas, to occur in islands and peninsulas surrounded by ciliated columnar epithelium.



The coryna divides the ciliary streams from the two main bronchi in such a way that there is a special concentration of flow on the anterior and posterior walls of the trachea. Both of these stream directly upward to the larynx with some tendency to spread. The posterior stream passes directly between the arytenoids to the rim of the larynx. The anterior stream passes up to the cords where the squamous epithelium acts like a barrier and the stream is divided in the midline in two parts, one passing backward under each cord and thence over the arytenoids to the interarytenoid space.

Possibilities are suggested for the relation of ciliary streaming to carcinogenesis involving the cords and to postoperative implantation in the trachea.

#### ST. LUKE'S HOSPITAL RESEARCH LABORATORY

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## LXII

### ELECTRICAL MANIFESTATIONS OF RECURRENT NERVE FUNCTION

C. J. CAMPBELL, M.D.

AND

JOHN A. MURTAGH, M.D.

HANOVER, N. H.

The function of the various fiber groups in the recurrent laryngeal nerve has long been a subject of dispute. It is frequently maintained that the nerve carries efferent or motor fibers only. The question of the existence of afferent (sensory) fibers has been raised by Kuttner and Meyer<sup>20-21</sup> and, on the basis of clinical observations, a negative answer given. Broeckaert<sup>4</sup> considers that in man the recurrent trunk is a mixed nerve carrying motor fibers for the larynx and motor and sensory fibers for the esophagus and trachea. Thus from his point of view the human nerve resembles that of the rabbit rather than that of the dog. The importance of species differences cannot be too much emphasized. The earliest experimental work with which we are familiar which bears directly on our problem is that of Sherrington<sup>38</sup> dealing with the cat and monkey. Some (the first seven) of his conclusions are given below.

1. "In a muscular nerve trunk from one third to one half of the myelinate fibres are from cells of the spinal root ganglion.

2. "The fibres range in size (in fresh preparations) from 1.5  $\mu$  to 20  $\mu$  in diameter.

3. "The largest of them are not the largest fibres in the muscular nerve trunk; the largest in the nerve trunk come from the ventral (motor) spinal root.

4. "The largest root-ganglion fibres in the muscular nerve are larger than any fibres in the cutaneous nerves of the limb, and than in any articular nerves examined.

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From the Hitchcock Clinic and Dartmouth Medical School, Hanover, N. H.  
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5. "The smallest myelinate fibres in the muscular nerve are for the most part, perhaps entirely, root-ganglion fibres.

6. "Macroscopic nerve-trunks are as regards their myelinate fibres in no case purely motor, all are sensorimotor or purely sensory. Such nerves as phrenic, hypoglossal, recurrent laryngeal, posterior interosseous contain abundance of fibres from sensory ganglia.

7. "For the root-ganglion fibres in muscles a special end organ exists, this is the so-called 'muscle-spindle'." (Kuhne)

In this same article there is reference to an amyelous fetus which is apropos:

"It is sufficient to make the general statement that no muscular nerve in the limbs, trunk, or neck was found wanting, although there existed not a single motor (ventral) spinal root in any segment. [Brain and spinal cord are completely wanting.] In view of present knowledge of the growth of the peripheral nervous system this must mean that all and each of the muscles of the limbs, trunk and neck receive abundance of myelinate fibres from the sensory root-ganglia."

Schultz and Dorendorf<sup>37</sup> show a tabulation of their review of the experimental work to that time which had been done on the rabbit, dog, cat and monkey in addition to their own work. The list shows 17 No's and 14 Yes's and one qualified answer to the question, "Does the recurrent contain afferent fibers?" They obtained evidence of afferent fibers in the rabbit and the cat and of no afferent fibers in the monkey. The afferent fibers in the peripheral recurrent of the dog and goat are considered to run through the anastomotic branch from the superior nerve. Boenninghaus<sup>2</sup> considers that there are afferent fibers in the human recurrent. Murtagh<sup>27</sup> reported no recorded responses when the central end of the cut recurrent nerve was stimulated (goat) by faradic current (induction coil) and considered that it appears that there are no afferent fibers in the recurrent. Later, Murtagh and Campbell<sup>28</sup> noted that with high intensity stimulation of the recurrent (goat) in its course respiration was stopped. It was considered that this might be due to spread or escape of stimulus to the vagus itself. In some experiments on laryngeal spasm Murtagh and Campbell<sup>30</sup> noted that section of the left recurrent nerve (goat) produced a transient inhibition of the right cricothyroid muscle. An explanation was not attempted, but it is not unreasonable to consider that the inhibition was central and due to

information carried by afferent fibers in the left recurrent which were stimulated by the cut.

#### ANATOMY

Chase and Ransom<sup>5</sup> investigated the structure (roots, trunk and branches) of the vagus in the dog. They consider that the myelinated fibers of the recurrent fall into two parts: one of large fibers, the other of medium and small fibers. Most of the smaller fibers are distributed in the cardiac, esophageal and tracheal branches. The nerve as it enters the larynx is made up entirely of larger fibers. This should emphasize that the recurrent in the neck is not strictly a laryngeal nerve. It becomes the "recurrent laryngeal" in the neighborhood of the larynx only. They also recalled to us that there are two root ganglia in the vagus, the jugular and the nodosum. This is also well brought out by Lemere<sup>23,24</sup> in his description of the innervation of the larynx in the dog. Lemere considers that the motor components of the laryngeal nerves are derived from the bulbar rootlets of the accessory (XI cranial). He has experimental evidence of afferent fibers though he is uncertain of the location of the cells of origin of these nerves. He calls attention to the anastomosis between the superior and inferior laryngeal nerves. Howell and Huber<sup>17</sup> report that in the dog the communicating branch probably contains only sensory fibers distributed mainly to the trachea and esophagus by way of the recurrent trunk. They also state that in their experiments stimulation of the central end of the cut recurrent never gave any effect on respiration or blood pressure. The cat was considered to resemble the dog. Rabbits did not.

Ransom, Foley and Alpert<sup>35</sup> report on the structure of the vagus nerve in the cat. DuBois and Foley<sup>6</sup> have made a detailed study of the vagus and accessory in the cat. They report that large medullated fibers degenerate after section of the bulbar accessory roots and that the evidence is that the cells of origin of many of the small fibers are in the nodose ganglion. Many of these small fibers go to the trachea and esophagus. They also note an anastomosis between the superior and inferior laryngeal nerves.

Brocklehurst and Edgeworth<sup>3</sup> considered that the recurrent nerve is made up of two components, laryngeal and sensory. They examined the fiber components in the macaque before and after section of the vagi at levels central to the jugular or to the nodose ganglion. Following section at either level most of the laryngeal component de-

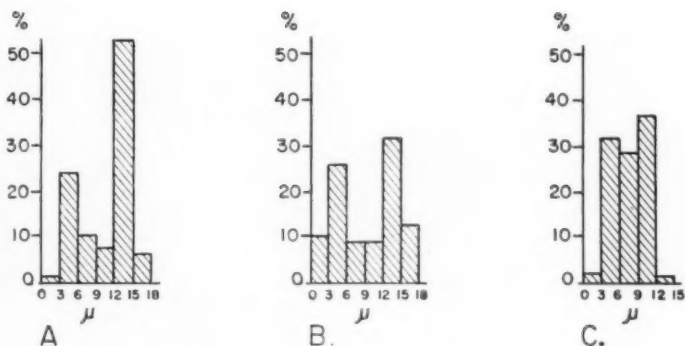
generates. The sensory component makes up about one third of the nerve fibers up to  $8.5\ \mu$  in diameter. Many of these fibers run to the trachea and esophagus and the few remaining at laryngeal level become continuous with a branch from the superior laryngeal nerve. They report that at the larynx the motor fibers divide into two bundles, one to the adductor and one to the abductor muscles. In this they agree with the findings of Russell<sup>36</sup> in the dog. When the vagus has been sectioned above the sensory root ganglia, there remains in the "laryngeal branches" only about three per cent of the myelinated fibers. These fibers have diameters up to  $10\ \mu$  and are considered to be proprioceptive sensory. A few "muscle spindles" are present in the laryngeal muscles. They also report scanty "muscle spindles" in the laryngeal muscles in man and in the cat. As cited by Pressman and Kelemen,<sup>34</sup> Rethi has shown that in the dog the efferent laryngeal fibers of the recurrent have their exit from the medulla via the bulbar rootlets of the accessory XI; and that the efferent fibers of the superior laryngeal nerve come from the vagal, X, rootlets.

Sunderland and Swaney<sup>39</sup> have carefully dissected the recurrent nerve in 65 human subjects and have found considerable variation in the peripheral arrangement of the branches and have also shown that if the various bundles are followed centrally they undergo considerable rearrangement and, in the human at least, do not follow the simple course that Russell<sup>36</sup> postulated in the dog.

Feindel, Henshaw and Weddell<sup>11</sup> raise the question of a dual innervation of the cricothyroid muscle and consider that each nerve (superior and recurrent) "gives rise to terminals which are distributed throughout the muscle rather than to any particular zone of it."

#### FIBER DISTRIBUTION

Eccles and Sherrington<sup>7</sup> report on the fiber spectra of "deafferented" motor nerves, of "demotored" motor nerves, and of sensory nerves. The results of their observations are perhaps most readily seen by looking at Figure 1, which has been redrawn from their data. They show that the efferent fiber spectrum of many skeletal muscles shows two maxima, one at about  $6\ \mu$  and the other in the neighborhood of  $15\ \mu$ . The afferent fibers from the muscles show no prominent maximum. (This is true as they plotted it. When the abscissa is rearranged to agree with our plots in Figures 3 and 4, this no longer holds.) Afferent fibers in sensory nerves may show a single maximum at about  $10\ \mu$ . O'Leary, Heinbecker and Bishop<sup>32</sup> have



## LEGEND:

Redrawn from Eccles and Sherrington (1930)

A. Efferent fibers only, ("Deafferented")

B. Afferent fibers only, ("Demotored")

C. Afferent fibers only, (Sensory nerve)

Fig. 1.—Fiber distributions in peripheral nerves. Redrawn from Eccles and Sherrington (7).

made an analysis of the function of a nerve to a muscle (cat gastrocnemius) with the intact nerve, the nerve after section of the dorsal roots, the nerve after section of the ventral roots, and after sympathectomy. Their conclusions are that about equal numbers of afferent and efferent fibers are present in both large and small fiber groups; that the large fiber group (efferent) is responsible for muscle contraction and that the small fibers innervate "muscle spindles"; that stimulation of large afferent fibers results in a release of tonus (if present).

A more recent work, Fernand and Young,<sup>12</sup> covers a much wider range of muscles. They classify the fiber spectra of muscle nerves (rabbit) as bimodal (two peaks) and as unimodal (single peak). The bimodal nerves contain many large fibers (14 to 20+  $\mu$ ), a few fibers in the 10 to 12  $\mu$  range, and a group of smaller fibers with a mode at 6 to 8  $\mu$ . This distribution is found mainly in the muscles of the limbs. Unimodal muscle nerves contain no large fibers. Among others, these include the phrenic and the recurrent laryngeal and the nerves to the thyrohyoid and the sternothyroid. They consider that the unimodal nerves contain a very few proprioceptive fibers. They

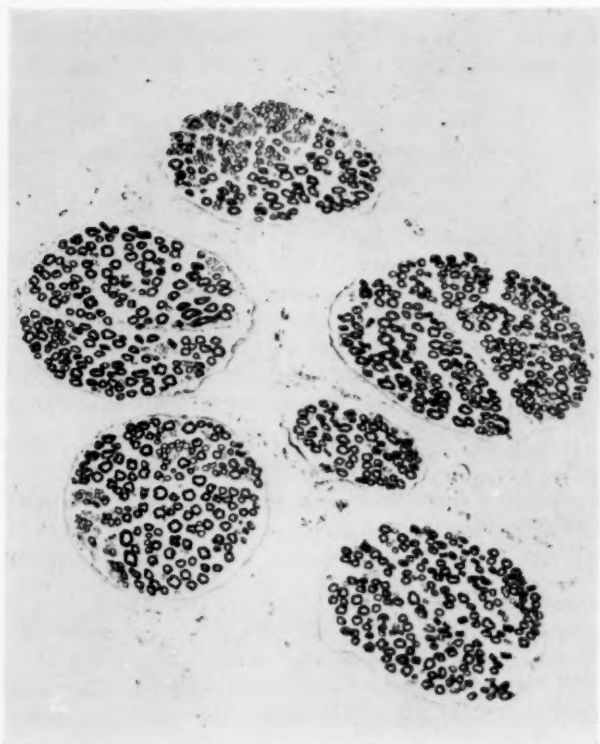


Fig. 2.—An osmic acid preparation of the recurrent nerve of the goat.

state, "We have definite evidence for the absence of afferent fibers from one nerve of this sort, namely, the part of the recurrent laryngeal that innervates the muscles of the larynx. Evans has found that following section of the vagus central to its ganglia all the fibers of this nerve degenerate." We have to date been unable to locate Evans<sup>10</sup> after a search of the literature.

Murtagh and Campbell<sup>20</sup> report the spectra found in the human, the goat and the cat recurrent laryngeal nerves. We now consider that perhaps these should have been reported as of the recurrent

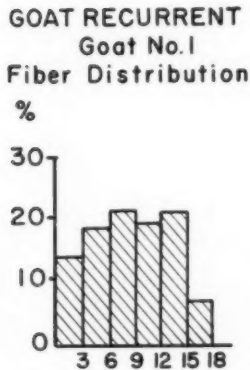


Fig. 3.—Fiber distribution in a recurrent nerve of the goat.

nerve. Most of the samples were taken in the neck rather than in the immediate neighborhood of the larynx. All the histograms are unimodal. An osmic acid cross section of the recurrent of a goat containing six fascicles is shown in Figure 2. Histograms of a six bundle nerve (goat) give the distribution in the entire nerve (Fig. 3) and in each bundle (Fig. 4). All are unimodal. Fascicles 5 and 6 may contain most of the presumptive motor (and proprioceptive) fibers. Fascicle 4 resembles most nearly the distribution of the entire nerve (Fig. 4). Fascicles 1, 2 and 3 contain most of the small fibers. (Cf. particularly Sunderland and Swaney<sup>10</sup>).

The recurrent nerve in the goat contains from four to sixteen bundles. This particular sample containing only six was chosen for convenience.

#### ACTION POTENTIALS

The foundation for the observation, using the cathode ray tube, of action potentials of peripheral nerve was established by Erlanger and Gasser.<sup>8</sup> Their fundamental work and that of others in the field for the next fifteen years has been collected and published in the Johnson Lectures, Erlanger and Gasser.<sup>9</sup> The action potentials from the vagus and the sympathetic nerve trunks (cat and turtle) have been examined by Heinbecker.<sup>15</sup> Heinbecker and O'Leary<sup>16</sup> have examined the mammalian vagus (cat); have recorded action

GOAT RECURRENT (Goat #1)  
Fiber distribution by bundles

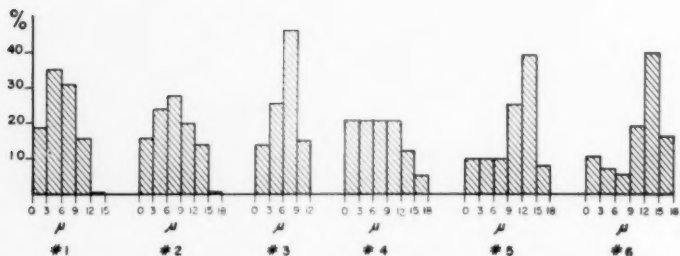


Fig. 4.—Fiber distribution in the individual bundles of the recurrent nerve shown in Figure 3.

potentials; have noted reflex responses to stimulation; and have done histological studies. They also examined in particular the recurrent nerve, which they found to be made up of two groups of medullated fibers. One group contains large fibers, 7 to 13  $\mu$ , which mainly degenerate when the vagus is sectioned above the nodose ganglion. Degeneration experiments appear to demonstrate that most of the cells of origin of the small fibers (2 to 6  $\mu$ ) are in the nodose ganglion. There were no action potentials recorded from the recurrent nerve.

O'Leary, Heinbecker and Bishop<sup>32</sup> previously cited also recorded and measured action potentials and plotted them against various quantities obtained by histological measurement and found a reasonable correspondence.

The superior laryngeal nerve has been stimulated in its course in conscious humans, and examined histologically. Following laryngectomy, the actions potentials of the excised nerve have been recorded by Ogura and Lam.<sup>31</sup> The potentials obtained were all those of the A group (Erlanger and Gasser<sup>9</sup>), probably in the subgroups alpha, and either gamma or delta. No potentials from nonmyelinated fibers were observed.

The physiology of the nerve endings (sensory) in mammalian muscle is exposed in detail by Matthews.<sup>26</sup> Katz,<sup>18-19</sup> using later and



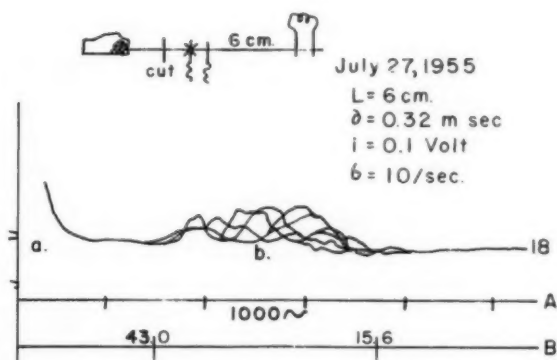


Fig. 5.—Monophasic action potentials from the goat recurrent in situ. Stimulus intensity just at threshold.

improved methods, records and discusses the action potentials from a single sensory nerve ending. The large number of small medullated fibers in the recurrent made the thesis of Leksell<sup>22</sup> particularly interesting. His records and analysis of the action potentials are especially good.

Paintal<sup>33</sup> has recorded action potentials in the cat from the central end of the vagus cut high in the neck, and from single fibers of the nerve in the same region. His interest was in the afferent fibers coming from the lungs and cardiovascular system, but the methods could be applied to the recurrent nerve. Unfortunately we were not aware of this work when we began our experiments.

Andrew,<sup>1</sup> interested in aortic baroreceptors and working with the rat, traced the afferent fibers from these receptors to the recurrent nerve, the communicating branch, and the superior laryngeal nerve. He used a single fiber technique and recorded action potentials.

#### METHOD

Goats were used throughout. The animal was given an initial dose of .045 to .060 gms per kilo of pentobarbital sodium and a continuous drip of 0.6 per cent solution of the same material to maintain the anesthesia. A tracheal cannula was inserted; the esophagus tied with a broad tape, after identifying the recurrences; and a recurrent

nerve then dissected for the greater part of its length in the neck. Stimulating electrodes, connected to a Grass square wave stimulator, and recording electrodes leading to a pre-amplifier, amplifier, and cathode ray oscilloscope were placed on the nerve. The nerve was crushed under the remote recording electrode to make the response monophasic. Repetitive stimulation was used. The traces on the oscilloscope were photographed on 35 mm film. The image on this film, when developed, was projected on a drawing board and the curves traced on paper. This gave an enlarged image and made it possible to select tracings that might be placed one over the other for comparison. A 1000 or a 2000 cycle wave was photographed periodically to provide a time axis. In some experiments the recurrent was removed and placed on stimulating and recording electrodes in a plastic moist chamber. Here also the nerve at the remote recording electrode was crushed and tied to the electrode.

In a third type of experiment the nerve and electrodes were left in place and additional electrodes were placed in the laryngeal muscles. Records were then obtained on a Grass electroencephalograph using the technique employed by Murtagh and Campbell.<sup>30</sup>

#### RESULTS

*Measurement of threshold and of conduction rate.* The possible variability of threshold for fibers of varying sizes conducting at various rates or the varying rate of conduction for the same fibers is shown in Figure 5. Actually this record was obtained when using a prolonged stimulus of a very low intensity in a very sensitive preparation with the central connections of the nerve intact. It should be noted, however, that the action potentials are synchronous with the sweep of the cathode spot (controlled by the stimulator); that no random responses are seen outside a rather limited time range; and that the nerve was cut beyond the crush at the distal electrode. It would appear that none of the recorded potentials can be of central origin or represent afferent pulses or back potentials from the muscles. Apparently the threshold for a few fibers with conduction rates of from 15 to 43 meters per second with a stimulus of 0.32 milli-seconds duration, repeated ten times per second, is in the neighborhood of 0.1 volt. These fibers are medullated, members of the group usually designated as A, and belong to the subgroups  $\alpha$  to  $\gamma$  (Fig. 6). When the intensity of the stimulation was increased the repeated action potentials all followed a single trace and exhibited none of this variability.

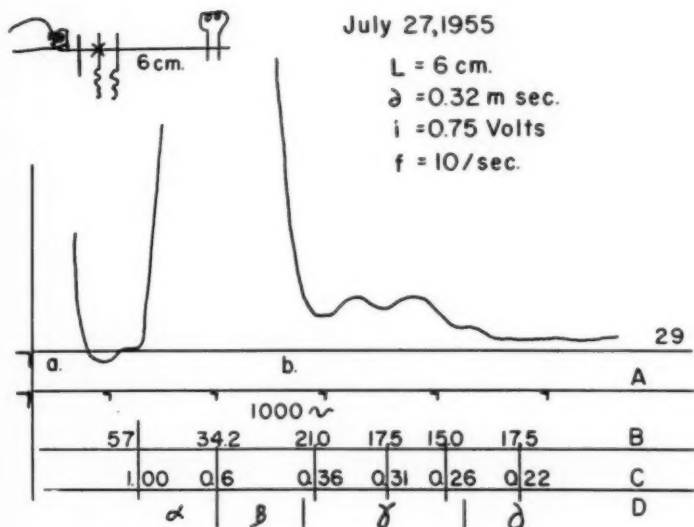


Fig. 6.—Monophasic action potentials from goat recurrent in situ. Stimulus adequate to show complexity of the potential changes.

ty. A record (Fig. 6) from the same nerve eleven observations (a few minutes) later is shown as the more usual occurrence. In Figure 5 (as in Figure 6) the upper trace is the action potential. The break in the line, a, is the stimulus artifact and here as in part b, the action potential, the spot is moving so fast that no record is obtained of the upper portions of the trace. The line A shows a series of dots spaced one-thousandth of a second apart. The figures along line B give the conduction rate in meters per second in the fibers contributing to the action potential at that point. Along C is shown the relative conduction rate of the various components. The small Greek letters in D show the subgroups to which the fibers belong, using the notation and values given by Erlanger and Gasser.<sup>8</sup> In Figure 7 are shown two action potentials from a nerve using different sized stimuli. The nerve has not been sectioned and the peak of the second component may contain a "back response" Lloyd<sup>25</sup> and Leksell.<sup>22</sup> This possibility has been indicated as perhaps accounting for the area above the dotted line. The muscles were not under observation at the time. The im-

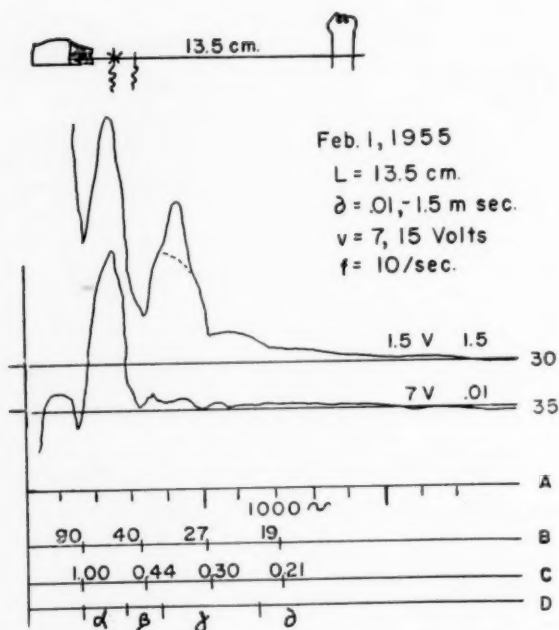


Fig. 7.—Monophasic action potentials from goat recurrent in situ. Extreme changes in duration and intensity of stimulation.

pulse may have jumped the small block presented by the crushing tie on the electrode and caused a contraction. The record is presented as further evidence for the occurrence in the recurrent of three and perhaps all of the subgroups of medullated fibers usually found in a mixed motor nerve.

Since the variety of response of the  $\alpha$  and  $\beta$  fibers is not well shown in the records presented, Figure 8 is included to show the  $\beta$  response and the spread of the  $\alpha$  pattern as the intensity is increased, using a stimulus of moderate length. These records were obtained from the peripheral end of an isolated nerve mounted in a moist chamber at a temperature of  $16.5^{\circ}\text{C}$ . This lowered temperature slows things down so that differences are exaggerated. Here it should be noted that some of the faster (larger) fibers require an intensity greater than that needed for their slightly slower (smaller) neighbors.

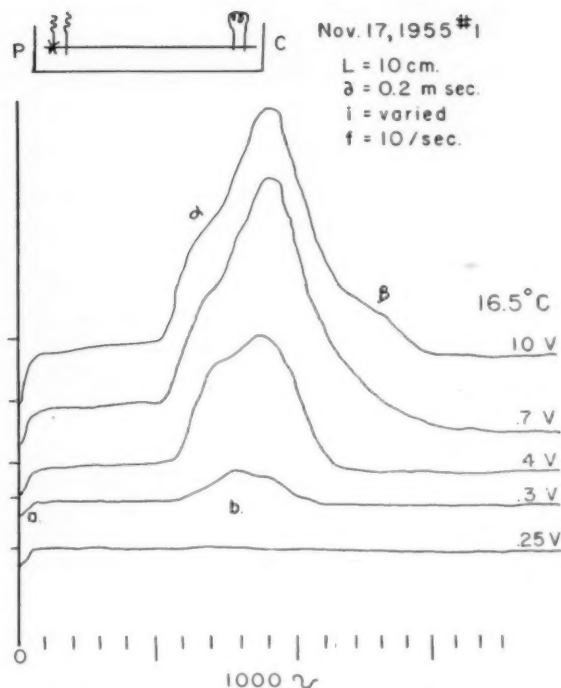


Fig. 8.—Monophasic action potentials of isolated goat recurrent. Constant duration of stimulus. Intensity varied from sub-threshold to near maximum for fastest fibers.

A tabulation of the threshold voltages at various durations gives data which when plotted does little other than emphasize the scatter. The fastest ( $\alpha$ ) fibers have thresholds at 0.01 msec duration of from less than 1.0 to 4.0 volts and conduction velocities of from 45 to 90 M/sec. Slower ( $\beta$ ) fibers at the same duration are excited by voltages of 2.0 to 4.0. The conduction velocity is somewhat difficult to determine but varies from 20 to 30 M/sec. The gamma ( $\gamma$ ) fibers show less variation in threshold, 7.5 volts at 0.01 msec, and exhibit velocities of from 11 to 30 M/sec. These variations, although all were measured with the nerve in place (after dissection), are probably due to the relative position of the particular fibers with relation to the stimu-

lating electrodes and to variations in nerve temperature. Probably nothing less than a single fiber method of stimulating and recording would be adequate.

The vapors of alcohol and ether were tried in the moist chamber. They seem to affect all fibers alike and effect no separation. In the moist chamber we were unable to observe any differential blocking of the various groups by lowering the temperature. All groups seem to react in a similar fashion and all become inexcitable at about 10.5° C.

Pressure up to 25 lbs./sq.in. applied for a few minutes cause little or no change in the potentials of the nerve in situ. We did not try prolonged pressure (30 to 60 minutes) but this maneuver is reported by Gasser and Erlanger<sup>13</sup> and by Leksell<sup>22</sup> to be effective in blocking the action potentials of the larger fibers, leaving nearly unchanged that of the smaller.

*Stimulation and the electromyograph.* In looking over many of the records, it seemed possible that leakage of stimulating current might be responsible for some of the changes in the electromyographs. All observations on such experiments have been omitted from the present report and reference is made only to such observations which do not include electrical stimulation.

In a previous experiment cited earlier (Murtagh and Campbell,<sup>30</sup> Figure 5), we obtained a record which seemed to show that there must be some afferent fibers in the recurrent. Electromyograms were recorded from the cricothyroid and the posticus on each side. The right recurrent nerve had been blocked with alcohol. The electromyogram from the right posticus was quiet. The other three muscles were showing a moderate, continuous background activity which, after an initial flurry on the left only, stopped when the left recurrent was cut. This inhibition lasted about a second after the section. No changes were recorded in respiration.

Since that time a number of electromyographic records have been secured following section or crush of the recurrent nerve.

All of them show increased activity of the cricothyroid, posticus and vocal cord on the same side during the cut. Usually this activity is very brief. One more prolonged than most is shown in Figure 9. Changes in ventilation and heart rate are usually slight. Occasionally there is apnea lasting for a few seconds. During the more recent

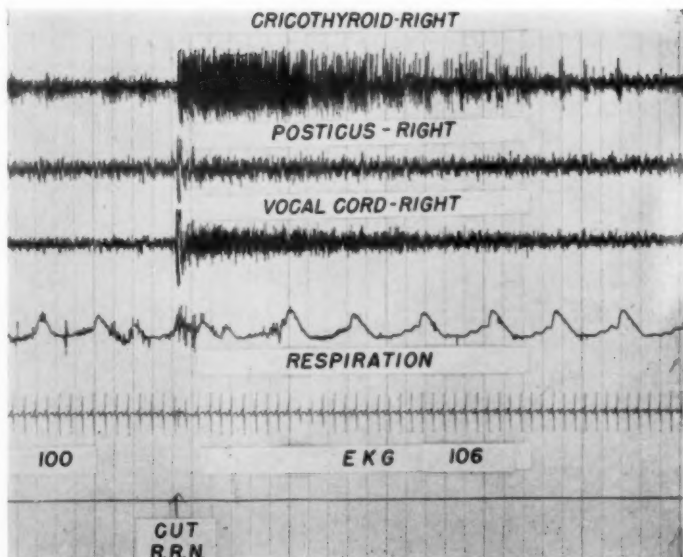


Fig. 9.—Simultaneous electromyograms from the musculature of the right larynx along with a record of respiration and an electrocardiogram. The right recurrent nerve was cut at the signal.

experiments we have recorded the electromyograms from one side only. This problem requires further work.

#### COMMENT

On a purely rational basis there must be some proprioceptive supply from the musculature of the larynx. The reasoning of Sherrington<sup>38</sup> calls for both afferent and efferent fibers in a motor nerve. The weight of the physiological and histological evidence presented is in favor of such a view. It is difficult to imagine a group of muscles which give such clear evidence of nice reciprocal inhibition as that shown in the electromyograms of Figure 10, operating without proprioceptive input. To be sure, reflexes other than simple proprioceptive are involved. The pulmonary stretch receptors (Green and Neal<sup>14</sup>) and perhaps also the pressure receptors from the great vessels (Andrew<sup>1</sup>) certainly act on the medullary centers to alter ventilation.

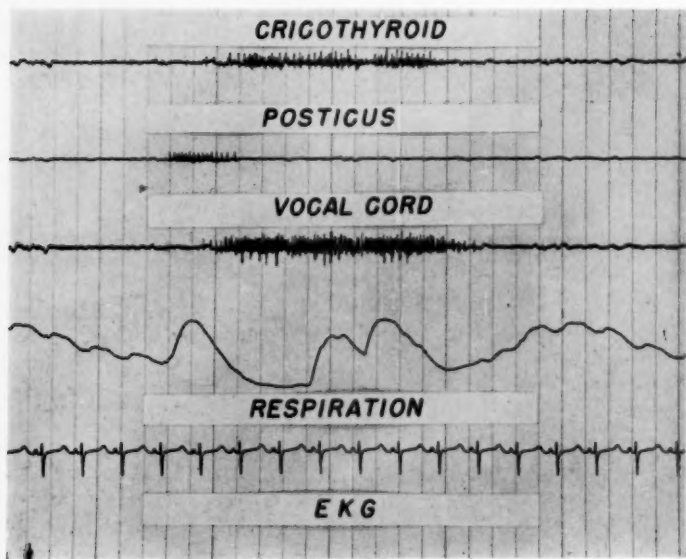


Fig. 10.—Reciprocal inhibition as shown in the electromyograph from the muscles of the right larynx. Air movement in the tracheal cannula and the electrocardiogram are shown below. Respiration was depressed by thioamylal.

The glottic muscles then take their proper part in the coordinated respiratory cycle. The nicety of performance must be due to information from the individual muscles.

The nature of the receptors within the muscle fibers has not been fully established. "Muscle spindles" have been reported in the macaque, man and the cat.<sup>3</sup> We have made preliminary examinations using a methylene blue technique for spindles. They were not found in the laryngeal muscles of the goat. Neither did we find any in muscles admitted by all to contain spindles. So far we have then not been technically adequate. We had hoped to show these (spindles) and thus make rational the large supply of small medullated fibers found in the recurrent as gamma efferents to the spindles reported by Leksell<sup>22</sup> and others.



In recording action potentials (as in the histological work) we have paid attention to medullated fibers only. The recurrent nerve appears to contain fibers in all of the groups ( $\alpha$ ,  $\beta$ ,  $\gamma$ ,  $\delta$ ) of the rapidly conducting fibers classed A. No attempt was made to secure at this time records from B or C fibers. As far as action potentials and conduction velocities are concerned the recurrent nerve differs from the mixed nerve supplying any skeletal muscle only in that it appears to contain no fibers conducting at rates of over 100 meters per second. This might be due to the experimental procedure (anesthesia, cooling of the dissected nerve), but the nerve contains none of the very large (18 to 20  $\mu$ ) fibers found in many "motor nerves."

We have always recorded from the peripheral (laryngeal) end of the nerve. This should have reduced the influence of tracheal and esophageal components. Further work should be done using the peripheral branches just as they enter the muscle. Microelectrodes have been prepared and it is planned to try single or small group fiber recording.

So far we have talked only of the A  $\alpha$  (motor and proprioceptor fibers) and A  $\gamma$  (possible gamma efferents). There is evidence of other groups ( $\beta$  and  $\delta$ ). These might carry other sensory modalities, pain, for instance. These fibers may also be involved in some of the reflex responses noted when cutting or crushing the recurrent.

The response of the ipsilateral cricothyroid to stimulation of the recurrent appears to confirm the thesis of Feindel et al.<sup>11</sup> that this muscle has a double nerve supply.

#### SUMMARY

All the experimental work was done on the anesthetized goat.

The nice reciprocal inhibition shown by antagonistic laryngeal muscles argues for a proprioceptive supply from these muscles.

The action potentials and the conduction velocities observed indicate that the recurrent nerve in its peripheral (laryngeal) portion resembles the mixed motor nerves of other skeletal muscle.

The cricothyroid muscle may have a double (superior and recurrent) nerve supply.

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LXIII  
SUBMUCOSAL COMPARTMENTATION  
OF THE LARYNX

JOEL J. PRESSMAN, M.D.

Although unknown to me at the beginning of these experiments, it has since been learned that many years ago Hajek demonstrated that if a liquid dye is injected beneath the mucosa of the larynx, the spread of the dye is limited to specific areas which can be mapped. This is of clinical significance from many points of view, but it is of special importance in the light of our studies which concern the use of radioisotopes injected into the larynx. The experiments consisted of attempts to identify and map these compartments and to study the flow or transmission of liquids from one to another as a preliminary to establishing a technique for the practical use of such radioisotopes.

The first observation resulted from the injection of dye into a living human larynx through a laryngoscope prior to performing laryngectomy. The dye was injected on one side into the true and false vocal cords. The anterior commissure was, of course, intact, since no incisions had been made. The purpose was to observe the fate and route of spread of the dye in the living human larynx. The laryngectomy was intentionally given to a new resident to perform, so that the removal of the organ was an unduly prolonged procedure requiring four hours. At the end of three hours, the larynx was finally removed, and the spread of the dye through the larynx could be observed. A sharp demarcation of the hemilarynx was evident. The dye had spread over only one lateral half of the larynx, while the opposite side contained no dye. There was no spread across the midline although the lymphatic system was functioning and intact.

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From the Department of Surgery, Division of Head, Neck and Plastic Surgery, University of California Medical Center, Los Angeles, California.

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We can, therefore, begin by saying that the larynx is compartmented into a right half and a left half, in so far as its submucosal structure is concerned. This has been found to hold true as a general principle for all larynges, either in living human subjects, cadavers, or experimental animals.

Externally, from a posterior view it was observed that this failure of the spread of dye to the opposite side occurred not only on the interior of the larynx but exteriorly as well, so that the posterior face of the arytenoid and adjacent tissues on the injected side were well-stained by the dye, whereas the posterior surface of the opposite arytenoid was not stained at all.

Realizing from this single observation that the problem was by no means a simple one, a technique was developed for injecting cadaver larynges since such material was more readily available. The limitations, as opposed to using living material, were, however, recognized. The first series of cadaver specimens was injected in the aryepiglottic fold above the level of the false vocal cord. By using controlled pressure, the dye was forced through the soft tissues to the border of the cartilage of the epiglottis, but not beyond it or across the midline. Its spread was downward to the level of the false vocal cord, but not below it. Apart from the division into halves, therefore, a compartment exists that extends over the supraglottic area above the level of the false vocal cord. It is of particular importance to note that when a massive injection is made on one side of the supraglottic area, the ventricle of the larynx remains clear of dye and is immune to the spread of fluids injected above it. The ventricle of the larynx is, compartment-wise, isolated from the false cord above it.

On repeating the supraglottic injection, but this time in the midline, the spread occurred to the right and left sides of the midline involving the entire epiglottis, whereas on lateral injection the cartilagenous area was uninvolved. Again there was no filling of the ventricle, so that it remained completely compartmentalized from the structures above it, even when large amounts of dye were used and the injection was made in the midline. The demonstration slide shows dye below the true cord on the opposite side as the result of an independent effort to fill the ventricle from below. This can be disregarded for the purposes of the moment.

We are vitally concerned, of course, with what happens to fluids injected in the region of the true vocal cord. When dye was injected

submucosally below the level of the true vocal cord, it also spread essentially to the midline. The slight intrusion of the dye as a tongue to the opposite side was an artefact, in that after one side filled with well-marked demarcation at the midline, efforts to increase the pressure ruptured the mucosa and a little dye penetrated to the opposite side. The lower limit of spread was at the inferior border of the cricoid cartilage without any evidence whatsoever of spread into the trachea. At the uppermost level, the dye reached the superior surface of the true vocal cord, but like the supraglottic injections did not actually enter the substance of the ventricle above.

From observations following injections both above and below the ventricle, it became obvious that both this structure and the immediately adjacent true and false cords required further detailed study, since the dye did not enter them either from above or below. In the first specimen demonstrated in the study of the region of the ventricle, the saccules were particularly prominent, filling the ventricle, and could easily be injected with dye. When injected, the sacculus bulged outward with dye. None passed upward into the false cord or downward into the true cord, so that the larynx or the vestibule of the ventricle represented other compartments which submucosally are entirely independent of the adjacent structures. A trifling amount of dye, however, traversed the lymphatics across the midline, and there was a suggestion of its entrance into the other ventricle. There was, therefore, passage across the midline, not from one true or false cord to the other side, but through the lymphatics from one ventricle to the other.

Apart from the sacculus, and not to be mistaken for it, is a prominent pearly-like margin, essentially the free edge of the vocal cord. It has been described and injected by Ottaviani and Sbermini, who called it a "bursa." If one takes a flexible needle on an automatically controlled injector and places it underneath the mucosa in this bursa (if one wants to call it that) a filling takes place which is sharply demarcated above and below. It does not pass across the midline and it can be filled to the point of rupturing without dye entering the sacculus which is above it. The dye will spread only over the margin of the true cord, including part of the superior surface, but not into the ventricle. By utilizing the opposite side of this same larynx and placing one injection in the true cord below the margin of this "bursa" and a second injection immediately above the bursa into the sacculus, the well-delineated bursal compartment

can now be demonstrated in a negative way by the filling of the tissues above and below it and the complete absence of dye in the bursa itself. Therefore, the bursa represents an additional isolated submucosal compartment along the margin of the true vocal cord.

In no instance, so far demonstrated, has the dye crossed the submucosal division at the mid-line, but since the experiments have been performed for the most part in cadavers, the spread of injected substances through the lymphatics has not been taken into consideration. Therefore, it is far more important to study dissemination of these dyes in the living.

The first of such experiments was performed in the dog. After the larynx was split through the anterior commissure, a small drop of dye was injected below the level of the true vocal cord under the mucosa. The dog was then photographed at hourly intervals.

After one hour, the margin of the vocal cord representing the "bursa" was free of dye. The dye had passed deep to the bursa, which likewise did not fill, and entered the superior level of the larynx. The free margin of vocal cord, which strangely enough is the site of so much pathology, particularly polypoid degeneration, and of many benign tumors as well as epithelioma, remained free of the dye.

After 12 days when the dog was sacrificed, one can see that, although the dye has for the most part disappeared, at no place has it crossed the midline to the opposite side of the larynx. It is true that the larynx had previously been split through the anterior commissure, but at least the posterior commissure remained intact and no cross-over took place across this site even after 12 days. Posteriorly, it can be observed that the dye has left the larynx and infiltrated the pyriform sinuses and hypopharynx on the same side as the injection.

To overcome the problem of having incised the larynx anteriorly and destroyed the continuity of tissues across the anterior commissure, studies were made by splitting the trachea transversely between the third and fourth rings, and by using a good head light the larynx was injected on one side from below, thereby leaving the anterior commissure intact.

With the anterior commissure of the larynx intact, the dye injected below the cords again spread superiorly from below to above.



The spread of the dye in the living dog after four hours again bypassed the free margin of vocal cord, thus eliminating the division of the anterior commissure as a factor in the isolation of the vocal cord margin from the remainder of the larynx.

This same experiment was also performed on a pig using the low tracheal incision without destruction of the anterior commissure and injecting the dye submucosally on one side below the level of the true vocal cord. The spread in the pig was especially interesting. The dye reached the midline, obviously not crossing it subglottically or supraglottically, but a very strange cross-over to the opposite side along the margin of the true cord was noted.

To determine what happens when dye is injected below the level of the cricoid cartilage in a living dog, the larynx and trachea were opened and a small segment of dye injected posteriorly. After five hours, the dye had spread downward into the trachea as far as the midline, but had not spread upward towards the larynx. If the injection had been made above the level of the cricoid cartilage, the dye would have spread upward, leaving the margin of the vocal cord free, and entered the ventricle. There is a vast difference in the distribution of dye when it is injected just below the level of the cricoid and when it is injected just above it. This factor may be of great clinical importance, and should be a matter for subsequent study. After a good many more hours, up to 12, there was still essentially no spread across the midline or, at the most, very little.

When it was massively injected into the aryepiglottic fold, dye spread posteriorly into the hypopharynx towards the region of the pyriform sinus and along the lateral walls of the hypopharynx. Anteriorly, it extended into the larynx along the lateral wall. Therefore, fluids injected into the region of the aryepiglottic fold have a distribution greater than that of injections at any other site.

Observations of cross sections made after the injection of dye show that submucosal injections do not cross the midline of the larynx at any level, even when made from below in an intact larynx with the continuity of the anterior commissure preserved. Also, the dye does not pass beyond the thyroid cartilage into the extra laryngeal space. At the lower most level of the cricoid cartilage, however, the dye does pass into the tissues of the neck making its way through the cricothyroid membrane via the recognized route of the lymphatic vessels. While one can observe a spread to the external surface of the



region of the larynx, even here there has been no spread across the midline.

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## LXIV

### CANCER OF THE LARYNX

FERNAND MONTREUIL, M.D.

MONTREAL, CANADA

Since the first laryngectomy was performed in 1873, much has been written on cancer of the larynx. It is not my intention to summarize the voluminous literature that has covered the many aspects of this subject, but only to review some of the cases treated in the Ear, Nose and Throat Service of Notre Dame Hospital in Montreal, from July 1, 1952 to December 31, 1955.

During this three and a half year period, 70 cases of laryngeal carcinoma were diagnosed. The first of these cases dates back but four years; because of the somewhat restricted period of follow-up elapsed since the termination of treatment, it is impossible at this time to give a factual evaluation of the various forms of treatment used. We all know of the good results claimed by various investigators with their different forms of treatment. I believe much can be learned by reviewing less successful cases, and for this reason it is my intention to emphasize on some of our failures.

These 70 cases of carcinoma of the larynx represent a little over 3.5 per cent of all cancers seen at the Cancer Institute, Notre Dame Hospital, during this period of time. This figure is in agreement with the incidence of between 1 and 5 per cent reported by various investigators. Sixty-one or 88 per cent were male, nine or 12 per cent were female patients. The youngest patient was a 22 year old male, and the oldest an 86 year old male who underwent laryngectomy with no ill effect. The incidence of cases in various age groups is seen in Table I. The average age of all patients was 58.27 years. In 1945, Jackson<sup>2</sup> stated that "cancer of the larynx is rare under 40 years of age and that in the experience of many investigators showed predilection for the sixth decade of life." We are seeing more and more cancers of the larynx in the younger age group. It is unfortunate that even in these young patients, the lesions are far advanced by the

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From the Ear, Nose and Throat Service, Notre Dame Hospital and the Department of Otolaryngology, University of Montreal, Montreal, Canada.

TABLE I  
CANCER OF THE LARYNX

(Incidence in different age groups at Notre Dame Hospital)

|             |          |
|-------------|----------|
| 20 to 39    | 5 cases  |
| 40 to 49    | 14 cases |
| 50 to 59    | 16 cases |
| 60 to 69    | 25 cases |
| 70 to 79    | 8 cases  |
| 80 and over | 2 cases  |

time diagnosis is made. The importance of an early diagnosis cannot too strongly be emphasized; it is up to us to impress the medical student and the general practitioner on the seriousness of a change in voice which tends to persist. An active program of education of the lay people by cancer societies should eventually show some results.

Numerous classifications of cancers of the larynx have been suggested since Isambert's first attempt to divide these tumors into intrinsic and extrinsic. This subject will remain most confusing until such time as an universal method of classification is adopted. We have classified our laryngeal carcinomas into intrinsic, extrinsic and extralaryngeal.

Laryngeal carcinomas are called intrinsic when the tumor is limited to the true cord only. They are extrinsic when the tumor involves structures other than the true cord but remains endolaryngeal. Lastly they are extralaryngeal when the tumor is outside the laryngeal box. Many cases of primarily intrinsic carcinomas are extrinsic by the time diagnosis is made. Ogura<sup>4</sup> has pointed out the importance and the difficulty of determining the exact site of origin of these tumors.

Our total of 70 cases were made up to 26 intrinsic, 34 extrinsic and 10 extralaryngeal carcinomas. Controversial predisposing factors such as syphilis, tuberculosis, bad oral hygiene, industrial fumes, etc. were not prominent in this group of cases. It is to be noted, however, that all these patients made use, to excess, of some form of tobacco.

All 70 cases were squamous cell carcinomas. Sarcomas, which occur more frequently in the younger age group, were not encountered. Neither did we see any intramucosal carcinoma.

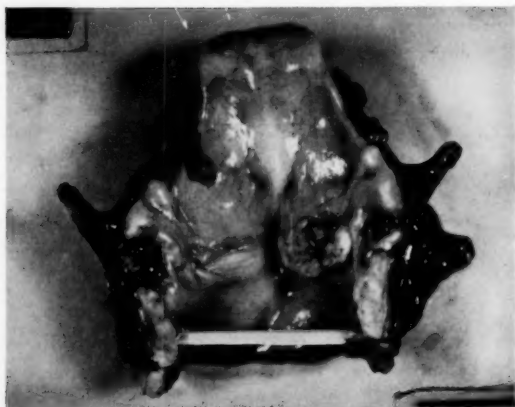


Fig. 1.—59 year old male complained of hoarseness for 1 year. Large papillomatous growth with malignant degeneration is still limited to the cord. Laryngectomy March 1954. Alive and well.

The symptoms of laryngeal carcinoma depend on the site of the lesion, and if a change in voice appears early in cordal lesions, such is not the case in extrinsic or extralaryngeal ones. Hoarseness, or a change of voice, becomes evident at the very onset of a cordal cancer. It may vary from a slightly huskiness to a near total aphonia and is persistent in nature. For a long time, it remains the one and only symptom, and the number of patients presenting this symptom who are treated with gargles, inhalations and what not, is still far too high. Symptoms such as cough, feeling of foreign body in the throat, bloody expectoration may all occur as the lesion progresses. When the tumor presents as a fungating growth and closes the lumen of the glottis, respiratory obstruction ensues. Five of the 70 patients came to the hospital because of dyspnea and required emergency tracheotomy.

Figure 1 shows an endolaryngeal tumor which probably had originated on the true cord but, by the time diagnosis was made, had become extrinsic. The passing of an endotracheal tube in such cases may easily traumatize the lesion and the risk of dislodging cancer cells and implanting them is a real one.

TABLE II  
CANCER OF THE LARYNX(Treatment of seventy cases—July '52 to December '55  
at Notre Dame Hospital)

|  |    |
|--|----|
| Laryngectomy                             | 25 |
| Laryngo-Fissure                          | 10 |
| Combined Laryngectomy and Neck           | 4  |
| Radiotherapy                             | 20 |
| Radiotherapy and Subsequent Laryngectomy | 3  |
| Thyrotomy                                | 2  |
| Secondary Neck Dissection                | 4  |
| Refused Treatment                        | 6  |

In patients with respiratory obstruction, Hoover and King<sup>1</sup> have recommended immediate laryngectomy instead of preliminary tracheotomy. I cannot agree with this statement and do not believe that one is justified in removing a larynx without histological proof of cancer. Furthermore, the patient is not psychologically prepared to undergo a surgical procedure which leaves him with so great a handicap as the loss of his voice. Extrinsic and extralaryngeal lesions give rise to more indefinite symptoms which are late in manifesting themselves. Dysphagia, lump in the throat, hoarseness, cough, bloody sputum, hypersalivation, dyspnea, otalgia may all appear, but so gradually, that the patient pays little attention to them. Not too infrequently a patient will consult because of a slowly growing mass in the side of his neck. In this group, the initial complaint was hoarseness in 54 patients and dysphagia in 13. In three instances, the presence of a mass in the neck prompted the patient to seek medical advice. The average time elapsed between the onset of symptoms and diagnosis was ten months.

A clinical impression of carcinoma is made by indirect laryngoscopy. A positive biopsy is necessary, however, before instituting treatment, whether it be surgical or radiation.

The advantages of taking the biopsy under direct laryngoscopy need not be emphasized upon. The surgeon should do his own laryngoscopy so that he may properly visualize all laryngeal structures and

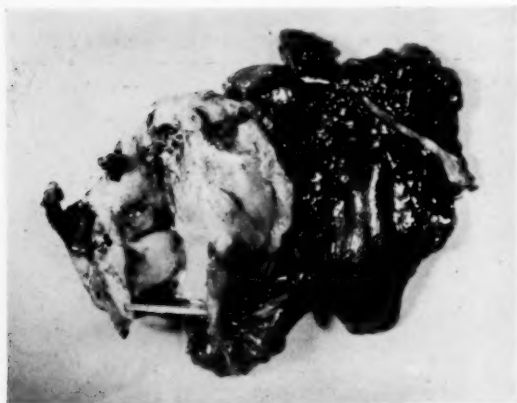


Fig. 2.—51 year old male complained of huskiness for 2 months, sore throat 3 weeks and mass in the neck 1 week. Lesion involved all of the hemilarynx. Combined neck and laryngectomy on January 1955. Alive and well.

appreciate the extent of the tumor mass. Regions which cannot be seen by mirror laryngoscopy can be properly visualized and inspected and unsuspected extensions in the ventricles or in the sub-glottis exposed.

It is beyond the scope of this paper to discuss the indications for the various forms of treatment. The treatment given our 70 cases is shown in Table II.

We believe that surgery offers the best chances of a cure, and in cases other than small cordal carcinomas, wide field laryngectomy has been considered the treatment of choice.

Four patients had a combined radical neck dissection and laryngectomy because of palpable lymph nodes (Fig. 2). One patient had a difficult postoperative course with prostration, elevation of temperature and crusting of the tracheobronchial tree which necessitated bronchoscopic aspirations on two occasions. He did not get out of bed till the fifth postoperative day. On the sixth postoperative day, his condition seemed to be picking up but, on the following morning, that is, on the seventh postoperative day, he suddenly became dyspneic and cyanotic and died within a few minutes. Death was caused by an embolus of the right pulmonary vein. The left

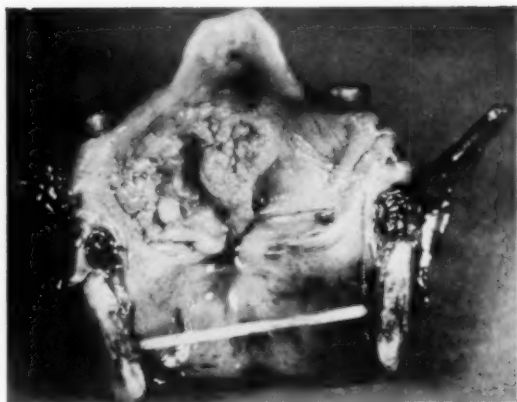


Fig. 3.—39 year old male complained of hoarseness and pain in swallowing for 4 months. Biopsy showed an undifferentiated squamous cell carcinoma with numerous mitotic figures. Patient returned 4 months after laryngectomy because of a node in his neck. Neck dissection in June 1954 and has been well since. This patient could neither read nor write and it was most interesting to see how well he rehabilitated himself after laryngectomy.

post tibial vein was completely thrombosed. Early mobilization of patients is most important to prevent venous stasis, responsible for many complications in the older patients.

Prophylactic neck dissection was not done in this group of cases. Six of the laryngectomized patients subsequently developed cervical metastases and four of them had neck dissections (Fig. 3). Of these six patients, five had presented a large extrinsic laryngeal growth and one, a very small cordal lesion which will be presented later. One of these patients developed cervical metastases, not from his laryngeal carcinoma but from a secondary, an independent lesion appearing on his hypopharynx two years after laryngectomy.

Cordal lesions have been considered as being unlikely to metastasize because of poorly developed lymphatic drainage. Extrinsic and extralaryngeal lesions, on the other hand, have been known to give metastases in a high percentage of cases. Ogura has shown that impalpable metastases were present in 31 per cent of endolaryngeal, 50 per cent of subglottic and in 57 per cent of extrinsic carcinomas.



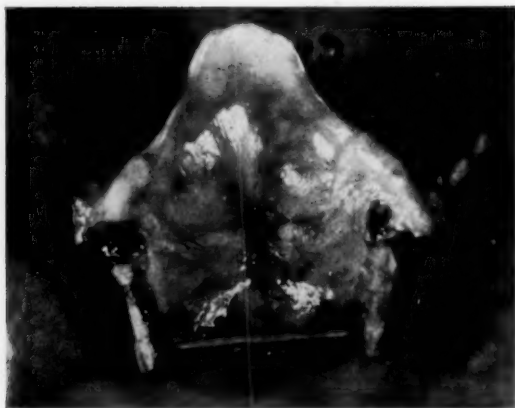


Fig. 4.—L.C., 41 year old male. Leucoplakia of both cords with microscopic area of carcinomatous changes. Most of carcinoma had been removed by biopsy. This patient developed a cervical metastasis 8 months later.

In the light of these recent reports and of the experience gained in our present series, I believe that prophylactic neck dissection is justified and should be done in cases of extrinsic and extralaryngeal carcinomas.

Cancer is most unpredictable at times as the two following cases will illustrate:

A 41 year old male had complained of hoarseness for two and a half months. Mirror examination showed leucoplakia of both cords. Biopsy reported malignant degeneration and laryngectomy was performed (Fig. 4). The examination of the surgical specimen revealed but one small microscopic area of malignancy. Following this pathological report, we considered that the patient had been treated rather radically and we expected to have him among our cured cases. Eight months later, he returned with a small ( $1\frac{1}{2}$  cm) node in the right upper jugular chain which had appeared within a period of one week. A neck dissection was done with much difficulty as the patient bled from everywhere and had abnormally large jugular veins. In the recovery room, he started bleeding in his wound; when brought back to the operating room it was found that the ligature

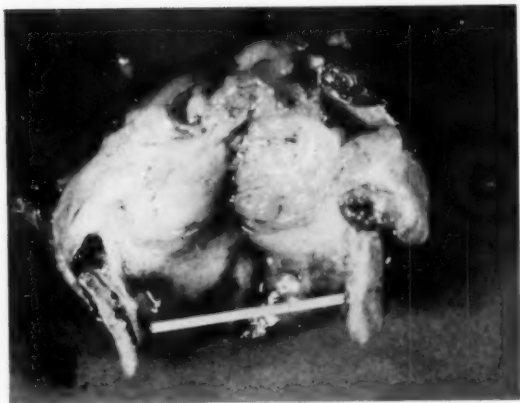


Fig. 5.—Surgical specimen of E.C. treated by radiotherapy and then laryngectomy. Histological examination failed to show persistent carcinoma.

on his internal jugular had come off. This was resutured and the patient's condition appeared fairly satisfactory. He reacted from anesthesia within a short time only to stop breathing one hour later; death came the following morning. Postmortem examination showed that he had died of cerebral edema. There was thrombus of the right cavernous sinus and an undeveloped venous system on the left. Cervical metastases from such a small lesion, limited to the vocal cord, are infrequent.

The next case should, by all standards, have given metastases and yet he is still alive and free from disease. A large fungating mass, involving the epiglottis and the base of the tongue, was first diagnosed as a poorly differentiated carcinoma in 1951. The patient was not given any treatment and came back to the hospital one year later; he was then seen because of dysphagia and some difficulty in breathing. Indirect laryngoscopy showed a large fungating mass involving the epiglottis, aryepiglottic folds and invasion of the base of the tongue. No nodes were palpable in the neck. It was agreed to treat him palliatively by radiotherapy. 7800 r were given in 62 treatments. The regression of the tumor was remarkable but there remained a suspicious irregularity of the epiglottis which was thought to be



Fig. 6.—Surgical specimen showing fungating growth of vallecula. The endotracheal tube was pushed through the tumor mass between the base of the tongue and the epiglottis.

residual disease. Five months after termination of radiotherapy, a laryngectomy was performed (Fig. 5). The skin of the neck presented marked x-ray changes and our apprehension in regards to closure of the skin proved to be right at the time of the first dressing. The wound had completely broken down and the patient developed a large pharyngeal stoma. Numerous attempts were required before obtaining final closure. During that time a basal cell carcinoma of the lower eyelid was treated and cured by the dermatologists. The operative specimen failed to show residual disease.

Twenty-three cases were treated by radiotherapy, and in three of these a subsequent laryngectomy was performed. The majority of these patients were treated by radiotherapy because of their refusal of operation, and the few other cases were treated palliatively because they were considered inoperable. It has been our good fortune to work in close co-operation with the radiotherapists, who quite agree that surgery is often the best form of treatment. All our patients are seen and followed by members of both services. The last case presented is an example of the effectiveness of radiation in certain instances. Unfortunately, we can not consider radiotherapy an easy

form of treatment. It is a prolonged process, local skin and mucous membrane reactions can be severe and the effects on the general condition of the individual cannot be ignored. Failure to arrest the growth, complications such as radionecrosis and perichondritis still occur and present serious problems.

In one other case, radiotherapy had again sterilized the tumor. Because of severe pain and near impossibility of swallowing due to radiation reactions, a laryngectomy was performed on this patient. In the first two cases where laryngectomy followed radiotherapy, primary closure was attempted and failed. In the third case, the patient was left with a large pharyngostoma with the intention of closing it secondarily. Following intense radiation, the skin becomes quite atrophic and the blood supply is greatly diminished. The skin is also rendered more susceptible to infection and necrosis. I think it is probably wiser to leave a pharyngostoma and close secondarily with grafts if necessary.

Before closing, I would like to add a few words on laryngectomy. A complete medical and blood work-up, including chest and esophageal films and tomographic studies of the larynx, is routine. A most important aspect of the work-up is the psychological preparation of the patient which is done by the surgeon, the social worker, the speech therapist and a laryngectomized person.

Laryngectomy is performed under local anesthesia, except when preceded by tracheotomy or when a combined neck and larynx operation is contemplated. The patient tolerates local anesthesia very well, the bleeding is cut down to a minimum and the necessity of passing an endotracheal tube is obviated.

If for some reason, general anesthesia is used and an endotracheal tube inserted, it should be done under visual control by an experienced anesthetist. Not long ago we did a combined neck, larynx and tongue resection (Fig. 6) and, on opening the hypopharynx, it was realized that the endotracheal tube was not in the glottis, but had forced a passage right through the tumor between the epiglottis and the tongue. The anesthetist had undoubtedly not properly visualized the glottis, and when asked if he had experienced any difficulty with the intubation, he replied in the affirmative, but he did not suspect in the least what had actually occurred.

A number of incisions may be used, but we find the "T" incision most satisfactory. The hyoid bone is completely removed and the

strap muscles are included in the specimen. Closure of the pharynx is done with chromic gut and skin with clips. No gastric tube is used and the patient is fed intravenously for four or five days. In normal postoperative courses the patient is allowed to leave the hospital within ten days following the operation. Rehabilitation of the patient is started immediately.

#### SUMMARY

A brief review of 70 cases of laryngeal carcinoma, seen during the period of July 1952 to December 1955, is given.

Because of the too short follow-up period, no attempt is made to give statistical results.

In the light of recent reports and from experience gained in these cases, neck dissection is considered justifiable in cases of extrinsic and extralaryngeal lesions.

902 SHERBROOKE STREET EAST

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The author would like to express his thanks to Dr. L. C. Simard, Director of the Cancer Institute, Notre Dame Hospital, for allowing to review the statistical reports and for the photography, all of which was done in his department.

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## LXV

### BENIGN TUMORS OF THE VOCAL CORD

#### CLINICAL VERSUS HISTOLOGIC DIAGNOSIS

SAMUEL SALINGER, M.D.

PALM SPRINGS, CALIF.

In the Standard Nomenclature of the American Medical Association, Fourth Edition,<sup>1</sup> one finds 137 items listed under the heading "Diseases of the Larynx." The Michael Reese Hospital Department of Pathology has 24 items in the cross file index under the heading of "Vocal Cord Lesions" including inflammatory conditions. Undoubtedly these lists are incomplete and do not include some of the rarer pathologic entities. Nevertheless, the list is imposing and should cover everything. Yet, despite its wide range or perhaps because of it, confusion often arises in properly designating some of the more common lesions that we see in everyday practice. This applies particularly to tumors or malformations on the vocal cords. In order to clarify my own thinking in this connection, I gathered the reports on 232 consecutive biopsies performed at Michael Reese Hospital during the past three years and compared the preoperative clinical diagnosis with the reports from the laboratory. The result is shown in Table I. I was amazed to note that only exceptionally did the two agree (Chart I). Reflecting on this apparent inconsistency, I concluded that we were either very deficient in clinical acumen or else there was something wrong with our nomenclature. One fact, however, did stand out, namely, that when we were dealing with true neoplasms our batting average was fairly respectable. For instance, of 63 cases diagnosed clinically as carcinoma, 43 were corroborated by the microscopic examination (Chart II). The remainder of this group represented a variety of conditions which might readily be suspect of malignancy from their gross appearance. Chart III shows a group of 17 cases diagnosed clinically as papilloma, in which only eight were so proven. True papillomata, particularly if multiple, have a charac-

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From the Otolaryngologic Service, Michael Reese Hospital, Chicago.

Photographs of microscopic slides by the Department of Photography, Strich School of Medicine.

CHART I

|                     | CLINICAL<br>DIAGNOSIS | MICROSCOPIC<br>DIAGNOSIS |
|---------------------|-----------------------|--------------------------|
| Carcinoma           | 63                    | 43                       |
| Polyp               | 81                    | 0                        |
| Benign Tumor        | 31                    | 28                       |
| Fibroma             | 19                    | 10                       |
| Papilloma           | 17                    | 8                        |
| Edematous Mucosa    | 7                     | 4                        |
| Keratosiis          | 4                     | 2                        |
| Vocal Nodule        | 4                     | 3                        |
| Inflammatory Tissue | 4                     | 1                        |
| Ulcer               | 1                     | 1                        |
| Fibroangioma        | 1                     | 1                        |

CHART II

CARCINOMA SO DIAGNOSED IN 63 CASES

| MICROSCOPIC DIAGNOSIS     |    |
|---------------------------|----|
| Carcinoma                 | 43 |
| Squamous cell hyperplasia | 4  |
| Thrombosed fibroangioma   | 1  |
| Papilloma                 | 5  |
| Tuberculosis              | 2  |
| Neurofibroma              | 1  |
| Chronic inflammation      | 3  |
| Granulation tissue        | 4  |



CHART III  
PAPILLOMA SO DIAGNOSED IN 17 CASES

| MICROSCOPIC DIAGNOSIS     |   |
|---------------------------|---|
| Papilloma                 | 8 |
| Fibroma                   | 2 |
| Lymphangioma              | 3 |
| Squamous cell hyperplasia | 2 |
| Mucosal fold              | 1 |
| Carcinoma                 | 1 |

CHART IV  
HYPERKERATOSIS - LEUKOPLAKIA CLINICALLY  
DIAGNOSED IN 4 CASES

| MICROSCOPIC DIAGNOSIS |   |
|-----------------------|---|
| Hyperkeratosis        | 2 |
| Carcinoma             | 1 |
| Mucosal fold          | 1 |

teristic appearance which the experienced laryngologist can recognize at the first glance. Solitary lesions, however, especially if small, though appearing grossly like papilloma may be something else, as the chart shows. We had only four cases diagnosed clinically as hyperkeratosis, two of which were so proven (Chart IV). One case turned out to be a carcinoma and the fourth was just a fold of thickened mucosa. There were four cases diagnosed as "vocal nodule," three of which conformed to the usually accepted histologic picture (Chart IV).

Coming now to the group in which the clinical diagnosis was "benign growth" we find a wide variety of conditions, among which there were two cases of malignancy (Chart V). I find no fault with the clinician who sees a nondescript lesion on the vocal cords which is patently not infiltrating and generally circumscribed, and labels it "benign growth." There is nothing characteristic about most of these lesions and I do not blame the laryngologist for not

CHART V  
VOCAL NODULE - SO DIAGNOSED IN 4 CASES

| MICROSCOPIC DIAGNOSIS     |   |
|---------------------------|---|
| Squamous cell hyperplasia | 3 |
| Edematous mucosa          | 1 |

CHART VI  
BENIGN GROWTH - SO DIAGNOSED  
CLINICALLY IN 31 CASES

| MICROSCOPIC DIAGNOSIS    |    |
|--------------------------|----|
| Fibroma                  | 11 |
| Granulation tissue       | 2  |
| Carcinoma                | 2  |
| Edematous mucosa         | 2  |
| Possible Boeck's sarcoid | 1  |
| Cyst                     | 4  |
| Hyperkeratosis           | 3  |
| Angioma                  | 3  |
| Lymphangioma             | 1  |
| Edematous polyp          | 1  |
| Papilloma                | 1  |

wanting to stick his neck out and presume to supplant the microscope with his naked eye. We are fully aware of the importance of doing a biopsy on every lesion of the vocal cord that is not an acute inflammatory process. This is the only way in which an early malignancy may be recognized, as was proven by the two cases discovered in this group.

However, when we look over the group clinically diagnosed as "vocal cord polyp" (Chart VI) we find that so far as the pathologist is concerned there is no such entity. How does it happen, then, that this term is so widely used? The word itself, derived from

two Greek roots, "poly" meaning many and "pes" meaning foot, is described by Dorland<sup>2</sup> as "a smooth pedunculated growth from a mucous surface as the nose, bladder, rectum, etc., the result of hypertrophy of the mucous membrane." Yet one would hesitate to say that a rectal polyp bears any resemblance histologically to a nasal or a vocal cord polyp. All that they have in common is their shape which, after all, is a poor criterion. It is interesting to note how various authors describe this growth. In Thomson and Negus "Diseases of the Nose and Throat"<sup>3</sup> we find this description: "A true polypus originates in Reinke's space as an initial congestion followed by edema and hyalinization." They state further that "a benign laryngeal formation of this type may occur although the term has been used incorrectly in relation to other simple growths or to formations of an inflammatory nature. It is doubtful if it is a true neoplasm." Thus it would seem that they recognize an entity which they term "true polypus" which they attribute to inflammatory reaction, while at the same time calling attention to other formations of an inflammatory nature with which it is not to be confused. What these other inflammatory masses may be is not explained in the text.

Laurens<sup>4</sup> states that under the general term of "polyps of the larynx" one includes benign tumors, liquid or solid developing in the mucosa and skeletal cartilages." Under this heading he describes vocal nodules, fibromas, cysts, lipomas, myxomas, angiomas, chondromas and papilloma, thus piling Pelion on Ossa and confounding confusion in nomenclature!

Ewing,<sup>5</sup> on the other hand, fails even to mention polyps, but describes the fibroma as being the most frequent tumor of the larynx and more than likely the same as the one we call polyp. He says, "it is a small peduncuated tumor on the true or false vocal cord near the anterior commissure; its structure varies; may be hard and mostly fibrous or soft and edematous."

Holinger and Johnston,<sup>6</sup> who reviewed 1197 cases, 43 per cent of which were classified as polyps, agreed with New and Erich that although their clinical appearance may be identical they may vary widely on histologic examination.

New and Erich<sup>7</sup> made it very clear that one must differentiate between neoplastic and non-neoplastic growths, the latter being generally the result of inflammatory process or local trauma. They very correctly pointed out that polypoid tumors may appear the same as

myxomatous laryngeal neoplasms "alike in gross appearance, in mode and time of onset, and in production and duration of symptoms, and are indistinguishable except on microscopic examination. Likewise they showed that true neoplasms such as angiomas fibromas and lymphangiomas are comparatively rare and not to be confused with the "edematous fibromas" or "hemangiomas" or so-called polyps as many of our cases have been designated.

Friedberg and Segall<sup>8</sup> demonstrated that the dominant features of polyps are edema, thrombosis and hyalinization, and that they develop out of the subepithelial space of Reinke because of its peculiar

CHART VII  
POLYP - SO DIAGNOSED  
CLINICALLY IN 81 CASES

| MICROSCOPIC DIAGNOSIS |    |
|-----------------------|----|
| Fibroma               | 30 |
| Papilloma             | 4  |
| Hemangioma            | 10 |
| Lymphangioma          | 6  |
| Neurofibroma          | 4  |
| Edematous mucosa      | 17 |
| Carcinoma in situ     | 2  |
| Granulation tissue    | 8  |

anatomic configuration and that they are in no sense to be considered as neoplasms. Ash and Schwartz<sup>9</sup> also called attention to Reinke's layer in which the mucosa is in close apposition to the deeper tissues at the striae arcuata. Lesions such as polyps, varix, amyloid, etc., are but various stages of the same process. Heavy concentration and intimate application of the elastica over the cord muscle serves as a barrier to deeper extension of these lesions. Glandular elements are comparatively scarce, which accounts for the rarity of cystic formations. Blood vessels and lymph spaces being exposed within these boundaries react to the exciting factors, thus yielding varying pictures resembling true angioma and lymphangioma. They state

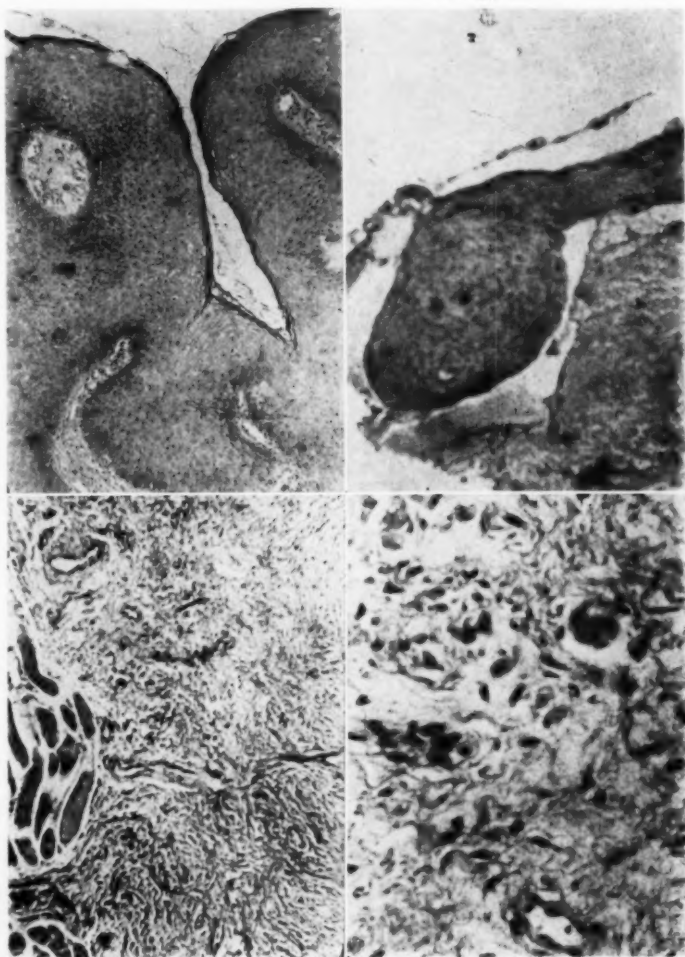


Fig. 1.—Papilloma.

Fig. 2.—Vocal nodule—Clinical diagnosis: Hyperkeratotic vocal cord. Microscopic diagnosis: Submucosal edema, old granulation tissue with overlying squamous cell hyperplasia.

Figs. 3 and 4.—Neurofibroma (53 C1 34)—Clinical diagnosis: Possible carcinoma. Microscopic diagnosis: Neurofibroma—transitional cell hyperplasia.

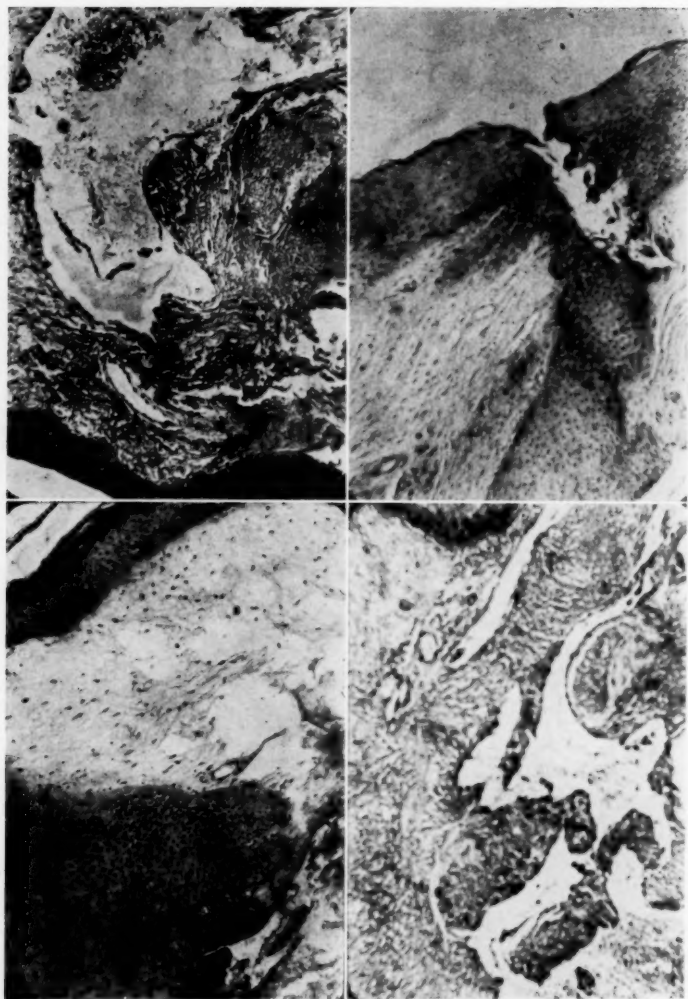


Fig. 5.—Lymphangioma (53P5091)—Clinical diagnosis: Vocal cord polyp. Microscopic diagnosis: Pedunculated lymphangioma.

Figs. 6 and 7.—Edematous fibroma: Papilloma (54P1669)—Clinical diagnosis: Polyps larynx. Microscopic diagnosis: Edematous fibroma and hard papilloma.

Fig. 8.—Hemangioma (52P4173)—Clinical diagnosis: Polyp vocal cord. Microscopic diagnosis: Pedunculated hemangioma.

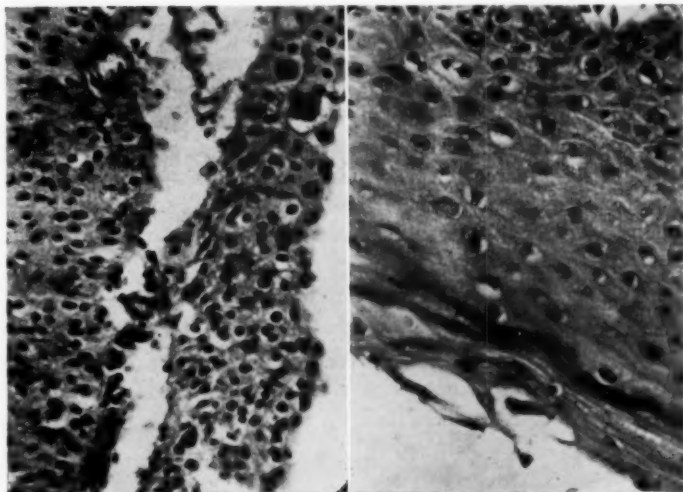


Fig. 9.—Carcinoma in situ (54P2242)—Clinical diagnosis: Vocal cord polyp. Microscopic diagnosis: Tumor cells are stratified squamous cell with large pleomorphic hyperchromatic nuclei. Occasional mitotic figures seen.

Fig. 10.—Carcinoma in situ (54P3397)—Clinical diagnosis: Vocal cord polyp. Microscopic diagnosis: In one section the squamous epithelial layer becomes disorderly and the cells exhibit pleomorphism. The nuclei are partly vesicular and partly hyperchromatic in type. A number of atypical mitotic figures are noted.

further that lesions such as polyps, varix, amyloid, etc., are but variations in the response to the same irritant.

Thus it would appear to be the consensus that the so-called laryngeal or vocal cord polyp is a non-neoplastic tumor-like formation originating out of the subepithelial space of Reinke and capable of assuming various histologic appearances depending on the degree of the irritating factor and the particular histologic elements most involved. Our pathologist seems to agree with this conception, as evidenced by his reports in our 81 cases (Chart VII). According to his analysis the predominance of changes in the fibrous and vascular elements appear to be the most frequently encountered. The diagnosis of "edematous fibroma" runs through a majority of this group. Yet, one would hesitate to call these true fibromas, hemangiomas or



lymphangiomas, since they lack the features commonly associated with true neoplasms. It is interesting to note that in this group, all clinically labeled "polyps," there were four cases of neurofibroma and two cases of carcinoma in situ. I doubt very much that the cases diagnosed as neurofibroma were true neoplasms, although such tumors have been reported. The appearance of elongated neural elements in quasi palisade formation may be only the reaction of these elements to the exciting factor which produced the mass. The true neurofibroma exhibits greater pleomorphism of the cells, occasionally giant cells, and a tendency to recurrence on removal with occasional degeneration into malignancy.

Since there is no acceptable histopathologic picture characteristic of the vocal polyp, I find it disconcerting and frustrating to see the term so widely employed. Even its gross appearance is not uniformly characteristic since it may be pedunculated or sessile, pale or injected, smooth or lobulated.

For myself, I am content to avoid using that term and to designate it a "benign growth of the vocal cord." The fact that the experienced laryngologist can determine from his clinical examination that at least 90 per cent of the lesions which appear benign to him are so proven by the laboratory examination, should be sufficient to justify the clinical diagnosis of "benign growth of the vocal cord" rather than "vocal cord polyp" implying something specific, which it is not.

1260 E. ALEJO ROAD

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NOTE: I am indebted to Dr. Otto Saphir, Pathologist at Michael Reese Hospital, for interpretation of microscopic slides.

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LXVI

PRIMARY MALIGNANT TUMORS  
OF THE UVULA

FRED Z. HAVENS, M.D.

AND

RICHARD C. YE, M.D.  
ROCHESTER, MINN.

Malignant tumors primary in the uvula are very rare. The standard textbooks of diseases of the nose and throat do little more than mention the fact that such tumors can affect the uvula. Because such lesions are so rarely encountered it is not surprising that most articles in the literature on this subject are limited to the report of a single case. Seven cases have been observed at the Mayo Clinic in the period 1919 to 1952 inclusive. The rarity of such lesions is emphasized by the fact that during this period some 1,500,000 patients were admitted to the clinic for examination.

Anatomists have described the soft palate as a backward projection of two layers of mucous membrane from the hard palate, enclosing muscles, an aponeurosis, racemose glands, arteries, nerves, lymph vessels and veins. A conical process known as the uvula projects from the middle of the posterior margin of the palate. It is composed chiefly of a mass of racemose glands and connective tissue covered by mucous membrane and containing slender prolongations of the musculus uvulae in its upper contractile part.

The physiologic function of the uvula was not fully described until 1948 when Richardson and Pullen<sup>1</sup> published their work on structure, function and importance of the uvula. It was considered to be a median-line structure which massages and moistens the posterior pharyngeal wall, aids in the removal of material from it and assists in the passing of this material downward to the hypopharynx and the base of the tongue. In other words it plays a fairly important role in the function of deglutition. These authors expressed the belief that the uvula has little if any importance with reference to speech.

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The Mayo Foundation, Rochester, Minnesota, is a part of the Graduate School of the University of Minnesota.

TABLE I  
REPORTS OF TUMOR OF THE UVULA COLLECTED BY STOUT

| CASE | TYPE OF LESION | AGE, YEARS | SEX | DURATION OF LESION | OPERATIONS  | RECURRENCE                      | MONTHS AFTER OPERATION |
|------|----------------|------------|-----|--------------------|-------------|---------------------------------|------------------------|
| 1    | Epithelioma    | 81         | M   | "Early"            | Biopsy only | —                               | —                      |
| 2    | Carcinoma      | 66         | M   | 3rd mo.            | 1           | Yes                             | 14                     |
| 3    | Epithelioma    | 37         | F   | 8th mo.            | 1           | No                              | 60                     |
| 4    | Carcinoma      | 49         | M   | 2nd mo.            | 2           | No                              | ?                      |
| 5    | Epithelioma    | 51         | M   | 2nd yr.            | 3           | No                              | 5                      |
| 6    | Carcinoma      | 52         | M   | 3rd mo.            | 1           | No                              | 14                     |
| 7    | Epithelioma    | 62         | M   | "Early"            | 1           | No                              | ?                      |
| 8    | Epithelioma    | 75         | M   | ?                  | 1           | No                              | ?                      |
| 9    | Epithelioma    | 56         | M   | 2nd mo.            | 1           | Cervical nodes<br>10 yrs. later | —                      |
| 10   | Epithelioma    | 41         | F   | "Early"            | 2           | Yes                             | 48                     |
| 11   | Epithelioma    | 64         | M   | 3rd mo.            | 1           | No                              | 5                      |
| 12   | Carcinoma      | ?          | M   | 8th mo.            | 3           | Yes                             | 2                      |
| 13   | Epithelioma    | 37         | M   | ?                  | 1           | No                              | 1                      |

Stout<sup>2,3</sup> reviewed the literature from 1858 to 1915 and found reports of 13 cases in which there had been a malignant tumor of the uvula (Table I). In the group there were four cases of carcinoma and nine of epithelioma. The data obtainable from these assembled case reports were not adequate to enable him to come to any definite conclusions regarding the behavior and treatment of the lesion.

In 1939, Robb and Michels<sup>4</sup> reported two cases of primary squamous cell carcinoma of the uvula and concluded that early excision offers a better prognosis than does irradiation alone. Frühwald,<sup>5</sup> in 1950, stated that he believed leukoplakia to be a factor predisposing to carcinoma of the uvula. In 1951, Tremble and Lockhart<sup>6</sup> reported a case of squamous cell epithelioma of the uvula which was excised together with the greater part of the soft palate. This was followed by deep x-ray treatment. Postoperative difficulty in swallowing liquids was only transient. One year later the patient was found to have no evidence of any recurrence.

#### THE PRESENT SERIES OF CASES

The data on our cases are summarized in Table II. Persistent soreness in the throat or pain on swallowing, or both, were the only symptoms encountered. Two patients had no complaints with reference to the throat and the tumor was found while a search was being made for a primary lesion to explain the presence of metastatic growths in the cervical lymph nodes.

The lesion may appear as an ulcer or the uvula may have a granular appearance and look as if it were indurated and stiff rather than flabby as is the normal uvula. In one of our patients the lesion was identified only when the posterior aspect of the uvula was inspected by means of a suitable mirror.

We believe excision of the local lesion, preferably with the electrocoagulating unit, to be the best method of treatment. Surgical dissection of regional lymph nodes was not carried out for any patient who did not have clinical evidence of involved nodes. In one case in which it was considered it was not done because the patient had active pulmonary tuberculosis.

Two of our patients had extensive metastatic lesions in the cervical nodes and a third had an intracranial metastatic lesion. In other words, in this group of seven patients each of whom had a relatively insignificant-appearing primary lesion, there were secondary lesions which led to disaster in 42.8 per cent of the cases. This

TABLE II  
PRIMARY MALIGNANT TUMORS OF THE UVULA

| CASE | AGE<br>SEX | SYMPTOMS AND<br>DURATION                               | EXTENSION<br>TO PALATE                       | METASTASIS<br>TO CERVICAL<br>NODES  | HISTOLOGIC<br>DIAGNOSIS                      |
|------|------------|--|--|-------------------------------------|--|
| 1    | 70<br>M    | No local symptoms,<br>Enlarged nodes in<br>neck, 6 mo. | Very little;<br>uvula "almost<br>eroded off" | Bilateral                           | Squamous cell<br>epithelioma<br>(not graded) |
| 2    | 63<br>M    | No symptoms;<br>lesion found on<br>examination         | No   | —                                   | Squamous cell<br>epithelioma,<br>grade 3     |
| 3    | 56<br>F    | Pain on swallowing,<br>6 mo.                           | Very little                                  | Left side;<br>extensive<br>and deep | Squamous cell<br>epithelioma,<br>grade 3     |
| 4    | 71<br>M    | Pain in throat run-<br>ning up to ear,<br>9 mo.        | No   | No                                  | Squamous cell<br>epithelioma,<br>grade 3     |
| 5    | 57<br>M    | Persistent soreness<br>on swallowing,<br>3 1/2 mo.     | Little                                       | No                                  | Squamous cell<br>epithelioma,<br>grade 3     |
| 6    | 65<br>M    | Persistent sore<br>throat, 2 mo.                       | Little                                       | No                                  | Squamous cell<br>epithelioma,<br>grade 2     |
| 7    | 59<br>F    | Persistent soreness<br>and pain in throat,<br>6 mo.    | No   | No                                  | Squamous cell<br>epithelioma,<br>grade 2     |

TABLE II  
AT THE MAYO CLINIC, 1919 TO 1952 INCLUSIVE

| TREATMENT   | LOCAL<br>RECURRENCE | OTHER DATA   |
|---|---------------------|--|
| None (inoperable)   | —                   | Axillary metastasis also; death 2 mo. later  |
| Excision, electrocoagulation  | No                  | Patient had also epithelioma of lower lip with bilateral cervical metastasis. Microscopic examination of tissue from lip and cervical nodes revealed squamous cell epithelioma, grade 4, in each region. Death 6 mo. later (metastasis from lip) |
| Electrocoagulation, dissection of neck, x-rays                          | No                  | Death within 1 yr.   |
| X-rays (elsewhere)  | Yes                 | Intracranial metastasis  |
| Electrocoagulation of residual tumor (uvula had been removed elsewhere) | No                  | No recurrence after 4 yrs.   |
| Electrocoagulation  | No                  | Dissection of nodes not done because of active pulmonary tuberculosis; alive after 3 yrs.  |
| Cautery excision, electrocoagulation                                    | No                  | No recurrence 1 yr. after treatment. Lived only 50 miles away; should return if any trouble.   |

emphasizes the importance of careful inspection of the uvula along with other parts of the oral and pharyngeal structures when conducting an examination.

#### MAYO CLINIC

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## LXVII

### MECHANICAL APPLIANCE FOR CICATRICIAL STENOSIS OF LARYNX AND UPPER PART OF TRACHEA:

#### REPORT OF CASE

JOHN B. ERICH, M.D.

ROCHESTER, MINN.

On analyzing the results of surgical techniques designed to correct cicatricial stenosis of the larynx, one finds that a satisfactory result can be anticipated in practically all cases in which the laryngeal and tracheal cartilages, and in particular the cricoid cartilage, are intact. However, when all or a large portion of the cricoid cartilage is lost through trauma or perichondritis and sequestration, the possibility of maintaining the patency of a newly constructed lumen through the larynx and upper part of the trachea is remote. In fact, loss of the cricoid cartilage practically always precludes the possibility of eliminating the wearing of a tracheal cannula. Such was the situation in the case which I wish to report in this paper. However, in spite of the fact that the tracheotomy tube could not be removed, a mechanical contrivance was devised to permit normal breathing through the nose and mouth and natural speech. This appliance or some modification of it perhaps might be of value for other patients with laryngeal stenosis in which the surgical treatment fails, and the patient must continue to wear a tracheal tube.

The patient under consideration had a traumatic injury to the larynx and subsequently complete laryngeal stenosis in the subglottic region due to perichondritis. Although there was some limitation of motion of the vocal cords, both of them did move satisfactorily. As will be pointed out later, it was discovered during the surgical repair of this stricture that practically all of the posterior part of the cricoid cartilage had been extruded due to sequestration. The loss of cartilage was associated with a sort of herniated protrusion of the

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From the Section of Plastic Surgery and Laryngology, Mayo Clinic and Mayo Foundation. The Mayo Foundation, Rochester, Minnesota, is a part of the Graduate School of the University of Minnesota.

underlying esophageal wall. This undesirable circumstance so complicated treatment of the stenosis that attempts to maintain the patency of a newly constructed laryngeal lumen had to be abandoned. However, the mechanical appliance previously mentioned has enabled the patient to carry on his normal activities with an unimpaired voice.

Some of the operative procedures undertaken in this case involve the form of treatment for cicatricial laryngeal stenosis which I employ and which I would like to review briefly before giving the details of the management of the patient.

#### TREATMENT OF CICATRICIAL STENOSIS OF THE LARYNX

The surgical exposure of the scar tissue causing cicatricial stenosis of the larynx or upper part of the trachea can be accomplished with the least amount of difficulty under local anesthesia—that is, infiltration of 1.5 per cent solution of piperocaine hydrochloride (metycaine).<sup>1</sup> An incision is made from the tracheotomy opening upward to expose the thyroid and cricoid cartilages. These are divided in the midline (Fig. 1). By separating the cut edges of these cartilages, the underlying laryngeal mucosa and the cicatrix can be incised in a vertical direction to expose the interior of the larynx and trachea as well as the constricted lumen in the region of the stricture. The scar tissue producing the obstruction then can be excised; this procedure restores the normal dimensions of the laryngeal and upper tracheal lumen. However, surgical removal of the cicatrix leaves a raw surface which, if of appreciable size, should be covered with a thin shave (Thiersch) skin graft. Such a graft offers a rapid method of epithelialization for the freshly denuded surface and tends to reduce the subsequent development of scar tissue.

A shave skin graft is wrapped around a sponge rubber mold which has been cut to fit snugly within the larynx and trachea (Fig. 1). The graft should be large enough to cover the sponge and is tacked down to the latter in several places with fine silk. The stent covered with a skin graft is held in place with a suture passed around the tracheal cannula and with two or three strong transfixation sutures which are passed through the neck and larynx from one side to the other.

After a week to ten days, the mold can be removed and invariably one finds that the skin graft has taken satisfactorily. At this stage, some form of obturator must be prepared to maintain the patency of the newly made lumen for several months. Otherwise, residual scar-

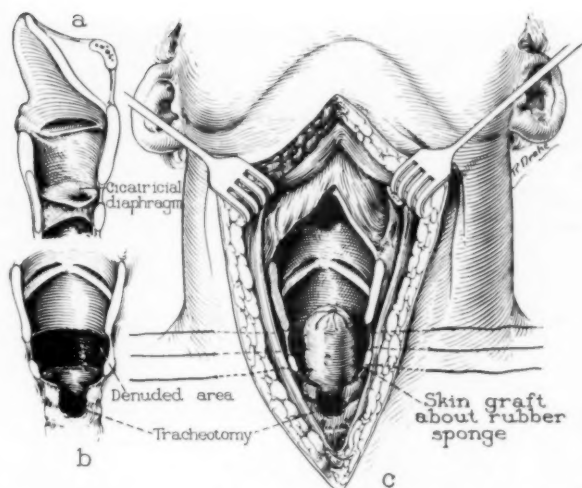


Fig. 1.—Surgical excision of the thickened scar tissue producing laryngeal or upper tracheal stenosis, with subsequent grafting of skin on the resultant raw surface. *a.* The subglottic stricture. *b.* The resultant raw surface after the surgical excision of the scar tissue. *c.* The surgical approach through the midline to the interior of the larynx and the method of grafting skin on the newly formed lumen. The sponge rubber mold covered with a skin graft is visible in the region of the newly formed subglottic lumen. Three silk sutures used for immobilization of this mold are visible.

ring in the walls of the larynx and trachea may contract to reproduce the stricture. Laryngeal obturators have been constructed in various materials. Some surgeons employ hard rubber tubing or sponge rubber for this purpose. Although rubber obturators do maintain patency of the laryngeal lumen, they do have certain disadvantages. They tend to elongate and then must be removed and replaced with one of proper size. Rubber obturators stimulate the formation of granulation tissue within the larynx as well as a discharge which may have a foul odor. Furthermore, there is often some difficulty in maintaining fixation of a rubber obturator in the larynx for a long time.

*The Acrylic Obturator.* I prefer obturators made of the plastic (acrylic) materials. They have the advantage of never changing shape; they are smooth, nonporous, nonirritating and tend to

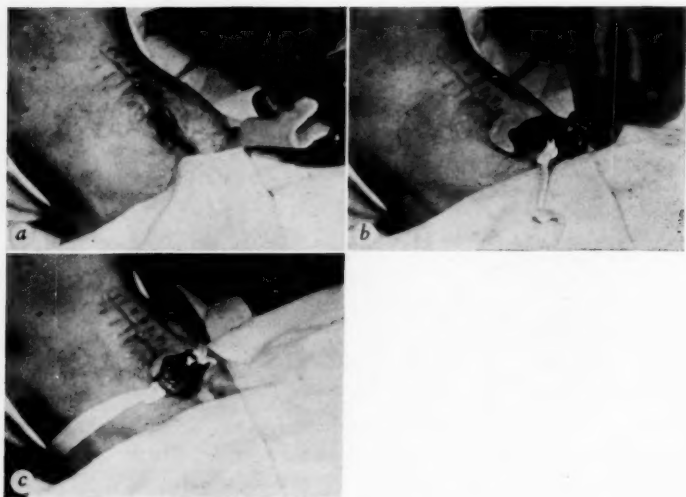


Fig. 2 *a*.—The finished acrylic obturator is about to be inserted through the external tracheal opening into the newly formed and skin-grafted lumen. *b*. The acrylic obturator is in position and the tracheal cannula is being inserted below. *c*. The acrylic obturator and the tracheal cannula in correct position.

inhibit the formation of granulation tissue. They produce no discharge and consequently no odor. The type of acrylic obturator which I employ has one disadvantage: it necessitates a large tracheal stoma. However, it is my opinion that the advantages of this type of obturator outweigh this one disadvantage.

The various steps required in the construction of an acrylic obturator are briefly as follows:

After removal of the sponge rubber mold from the larynx, a section of large-size rubber tubing is cut to equal the length of the sponge rubber mold. This piece of rubber tubing is coated with petrolatum and is introduced in an upward direction through the external tracheal opening into the larynx. If the tracheal stoma is not of sufficient size vertically to permit insertion of the rubber tube, the opening must be enlarged by an upward incision in the median

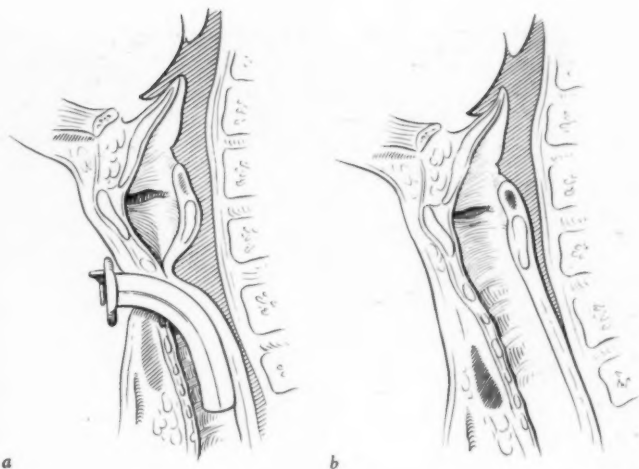


Fig. 3.—Sagittal section of larynx. *a*. Patient had cicatricial stenosis of the subglottic region of the larynx which completely obliterated the laryngeal lumen. This stenosis was associated with a sort of herniated protrusion of the anterior wall of the esophagus into the cicatricial mass in the larynx. *b*. Normal trachea and esophagus shown for comparison with the stenosed larynx in *a*.

line. After the rubber tube has been seated within the larynx, the tracheal cannula is inserted. A piece of silk suture thread which has previously been inserted through the lower end of the rubber tube anchors the latter in the larynx to the tracheal cannula.

A small piece of dental impression compound is softened in a pan of hot water. This soft compound is forced into the tracheal opening above the tracheal cannula and to the rubber tube within the larynx. The suture anchoring the rubber tube to the tracheal cannula is out, thus permitting withdrawal of the tracheal cannula, the extension made of dental compound, and the piece of rubber tubing in the larynx. The extension and the rubber tube are assembled in the same relationship to each other as existed when located within the larynx. These two structures are made to adhere with melted wax. After the two open ends of the piece of rubber tubing have been blocked with wax, the model consisting of the piece of

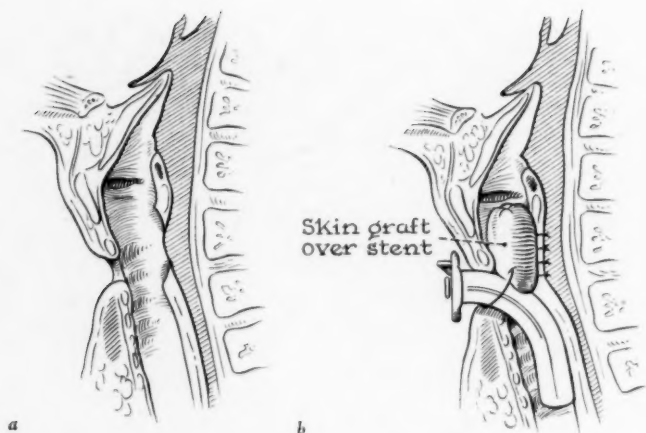


Fig. 4 *a*.—Sagittal section of larynx after excision of the scar tissue forming the subglottic stenosis which resulted in an opening (tracheo-esophageal fistula) from the larynx and trachea into the esophagus as illustrated. *b*. The lateral edges of this tracheo-esophageal perforation were sutured together; the raw surface within the larynx due to excision of scar tissue was skin-grafted by applying a Thiersch graft over a sponge rubber stent as illustrated.

rubber tube and the dental compound extension is sent to the dental laboratory for processing in one of the acrylic materials.

While the acrylic obturator is being made, the original sponge rubber mold should be reinserted into the larynx and anchored around the tracheotomy tube with a silk suture. If this sponge rubber mold were not inserted during the several hours which are required for construction of the obturator, the newly formed lumen within the larynx would become so contracted that the introduction of the obturator would be impossible.

When the acrylic obturator has been finished by the dental laboratory, the sponge rubber mold and tracheotomy tube are again removed. The obturator is promptly introduced through the tracheotomy opening into the newly formed laryngeal lumen (Fig. 2). Subsequently, the tracheal cannula is inserted into the trachea just below the obturator. The forward extension of this obturator rides

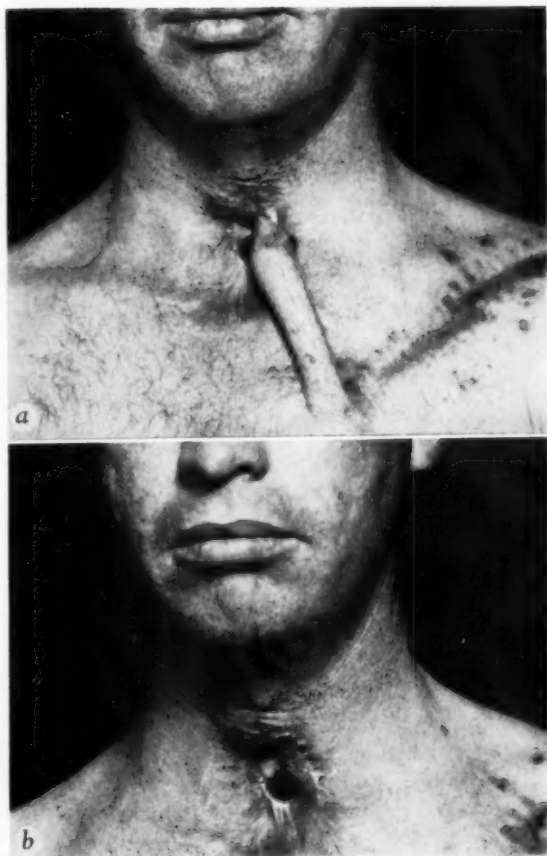


Fig. 5 *a*.—Lateral end of the clavicular tube flap transferred to cover the tracheo-esophageal fistula. All of the laryngeal mucous membrane on the lateral and posterior walls of the larynx in the region of the fistula was excised before the tubed pedicle flap of skin was applied. *b*. The unused part of the clavicular tube flap has been cut off and discarded. The fistulous tract has been permanently closed. However, the use of the pedicle flap of skin within the larynx has so reduced the size of the laryngeal and tracheal lumen that removal of the tracheal cannula is impossible.



Fig. 6.—Sagittal section of larynx and trachea. The tracheo-esophageal fistula has been covered with skin from a clavicular tube flap. Notice how the use of this flap of skin has reduced the size of the laryngeal and tracheal lumen.

on top of the tracheotomy tube and emerges through the tracheotomy opening. This extension prevents any upward or downward displacement of the obturator whether or not the tracheal cannula is in position. If, at any time, the surgeon wishes to examine the interior of the larynx, the tracheotomy tube and obturator can be removed through the tracheotomy opening and the examination performed as an office procedure.

In my experience, such an obturator must be worn for three to six months if the patency of the newly formed laryngeal lumen is to be maintained. On removal of the obturator several months later, if the laryngeal lumen stays open satisfactorily, the large tracheal stoma can be closed. Several years ago, it was thought that this large opening required a pedicle flap of skin for closure. However,



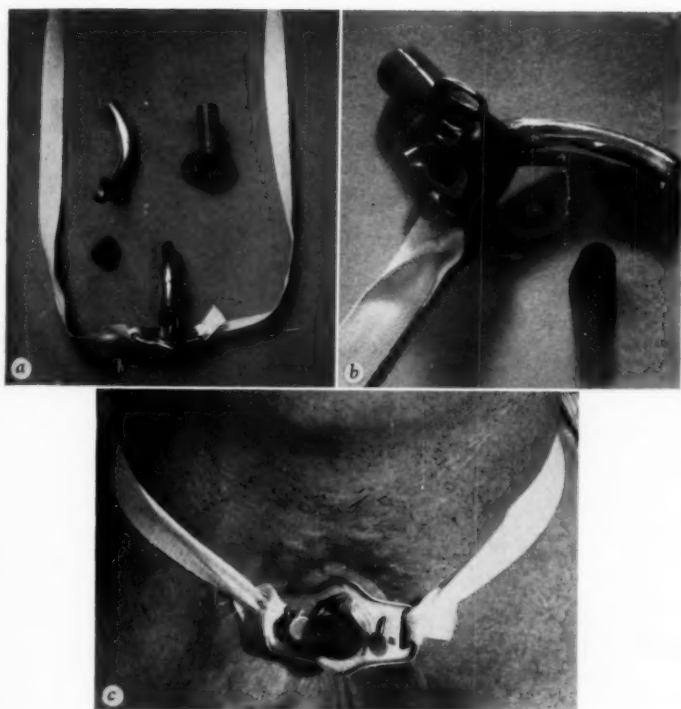


Fig. 7 *a*.—Mechanical appliance used in conjunction with a tracheal cannula to enable the patient to breathe through his mouth and nose and to speak in a normal manner. The acrylic device is shown on the upper right. The inner and outer tracheal cannulae are shown; a hole in the top of each of these cannulae at the site of contact with the acrylic appliance is visible. The rubber cork used to occlude the normal outer opening of the tracheotomy tube is also illustrated. *b*. The appliance has a ringlike extension below, through which the tracheal cannula is inserted. *c*. Appliance and tracheal cannula in proper position.

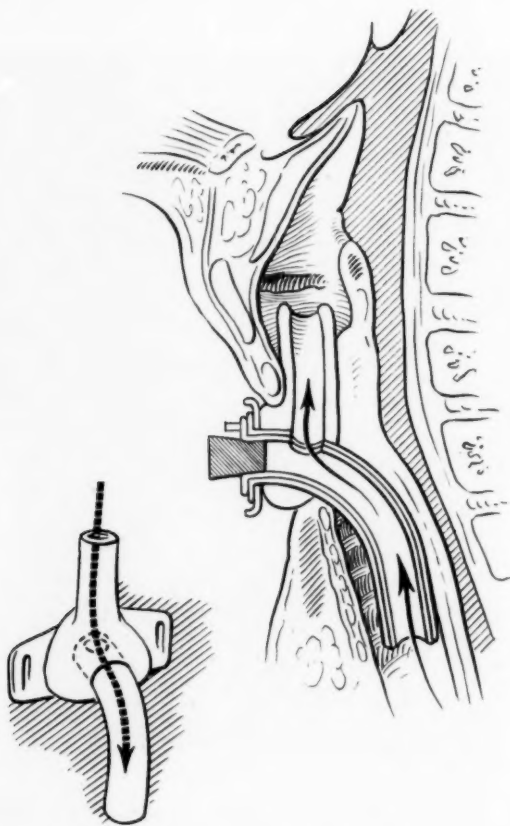


Fig. 8.—Sagittal section of larynx. Tracheotomy tube and acrylic appliance are in place; the arrows indicate the passage of air from the trachea into the larynx when the rubber cork is inserted into the tracheal tube. Relationship of the acrylic appliance to the tracheal tube is illustrated in the inset. When the tracheal tube is corked, the patient breathes normally through the nose and mouth and can speak with no difficulties.

I have found that the tracheal opening will shrink down in size within a few days so that it can be closed by simple approximation, freshening and suturing of the lateral edges.

#### REPORT OF CASE

The patient, a young man, 26 years of age, was wearing a tracheotomy tube when he came to the Mayo Clinic in April, 1953. It was found that the laryngeal obstruction in this case was due to a subglottic cicatricial stenosis which completely obliterated the laryngeal lumen (Fig. 3). This defect was the result of an automobile collision that occurred a year previous to his registration at the clinic. During the accident, the patient had struck his neck against the steering wheel, which fractured his larynx and later produced perichondritis with loss of a large part of the cricoid cartilage.

On examination of the larynx, I was rather surprised to find that the patient's vocal cords seemed to be free and moved fairly well. After a thorough study of this stenosis by x-ray examination of the larynx and under indirect and direct suspension laryngoscopy, it was decided that the routine treatment for stenosis which has been described should be carried out.

Accordingly, thyrotomy was performed at which time a large dense mass of scar tissue was found in the subglottic region just above the tracheotomy opening (Fig. 3a). Sharp excision of this bulk of scar tissue left an opening from the larynx and trachea into the esophagus (Fig. 4a), a circumstance which I have never encountered before or since in the treatment of laryngeal stricture. The reason that this complication did occur in this case was the result of total loss of the posterior part of the cricoid cartilage associated with a sort of herniated protrusion of the anterior wall of the esophagus into the cicatricial mass in the larynx (Fig. 3a). The lateral edges of this perforation into the esophagus were sutured together and skin was grafted about the newly formed lumen in the larynx in the usual manner by applying a shave skin graft around a sponge rubber stent (Fig. 4b).

Ten days later when the rubber mold was removed, it was found that the new laryngeal lumen looked very satisfactory, although a small hole was still present into the esophagus. Regardless of this fact, an acrylic obturator was prepared in the usual manner and inserted into the larynx. The patient had no difficulty with the tracheo-esophageal fistula as long as the acrylic obturator was worn. However, when this appliance was removed, food and liquids came through the fistulous tract into the trachea during the act of swallowing. When the fistula had not healed in a month, I attempted to close this tract with a small flap of mucous membrane which was elevated adjacent to the tracheo-esophageal opening. Unfortunately, the flap did not heal into place satisfactorily because there was too much motion of the esophageal wall during swallowing.

It became imperative that this fistula be closed, and consequently I constructed a tube flap of skin obliquely across the left clavicle. One month later, the lateral end of this tube was elevated and transferred to the laryngeal region (Fig. 5a). All of the laryngeal mucous membrane on the lateral and posterior walls of the larynx in the region of the tracheo-esophageal fistula was excised. This denuded surface, as well as the fistulous opening itself, was covered with the lateral end of the clavicular tube flap. Healing was complete in three weeks after which the unused part of the clavicular tube was cut off and discarded. By this plastic procedure, the

fistulous tract was permanently closed (Figs. 5*b* and 6). However, the use of the pedicle flap of skin within the larynx so reduced the size of the laryngeal lumen that removal of the tracheal cannula was out of the question (Fig. 6). Moreover, it seemed useless to attempt any further reconstruction of the laryngeal lumen for fear of reopening the tracheo-esophageal fistula.

#### THE MECHANICAL APPLIANCE FOR PERMANENT USE

In view of the fact that the constricted laryngeal lumen never would permit the patient to dispense with his tracheal cannula, I devised a small appliance which is used in conjunction with the cannula and which makes breathing through the mouth and nose and normal speech possible. This device, first made in wax and then changed to an acrylic material, consists of a tube with a ring-shaped extension below, through which the tracheal cannula is thrust (Figs. 7 and 8). The appliance is introduced through the tracheotomy opening into the larynx with the ring extension protruding externally. After seating the device in the larynx, the tracheal cannula is inserted through the acrylic ring into the trachea. A hole in the top of the cannula at the site of contact with the acrylic appliance allows air to pass freely from the cannula into the appliance and consequently between the patient's mouth and nasal passages above and the trachea and bronchi below (Figs. 7 and 8). However, breathing through this device and the cannula requires use of a rubber cork to block off the external opening of the tracheotomy tube (Figs. 7 and 8). Air then expelled on expiration passes up between the vocal cords and permits the patient to speak normally. The appliance and tracheal cannula can be removed for cleansing at any time and have been worn by the patient with satisfaction for two years.

MAYO CLINIC

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## LXVIII

### USE OF THE LARYNX IN REPAIR OF CICATRICIAL STENOSIS OF ESOPHAGEAL INTROITUS:

#### REPORT OF CASE

JOHN B. ERICH, M.D.

ROCHESTER, MINN.

A cicatricial stenosis of the esophageal introitus usually presents a decidedly challenging problem in therapy. Frequently, correction of such a defect requires laryngectomy, removal of the cicatrix and reconstruction of the upper end of the esophagus. Such management not only becomes extremely involved but not infrequently ends in a repair that is none too satisfactory. In the case which I wish to report in this paper, a complete stricture at the entrance of the esophagus was treated surgically by dividing the trachea from the larynx, cutting across the esophagus just below the stricture and connecting the cut edge of the gullet to the mucosal lining of the larynx. In so doing, the larynx became the upper end of the esophagus and, in this particular case, functioned exceptionally well.

The technique of this operation is somewhat different from that described by Asherson. The patient on whom he reported had undergone pharyngectomy for postericoid carcinoma; after removal of the thyroid cartilage the laryngeal mucosa was attached to the stump of the esophagus, thereby making a connecting link between the pharynx and the gullet. A recent article by Wilkins outlines a method of extirpating the laryngeal cartilages and using the mucosa of the larynx in reconstruction of the esophagus for patients in whom a malignant neoplasm of the upper end of the esophagus has been excised. In the last-named technique, some difficulty was encountered in keeping the tract open, and dilatations were required.

#### REPORT OF CASE

The patient was a man, 68 years of age, who came to the Mayo

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From the Section of Plastic Surgery and Laryngology, Mayo Clinic and Mayo Foundation. The Mayo Foundation is a part of the Graduate School of the University of Minnesota.

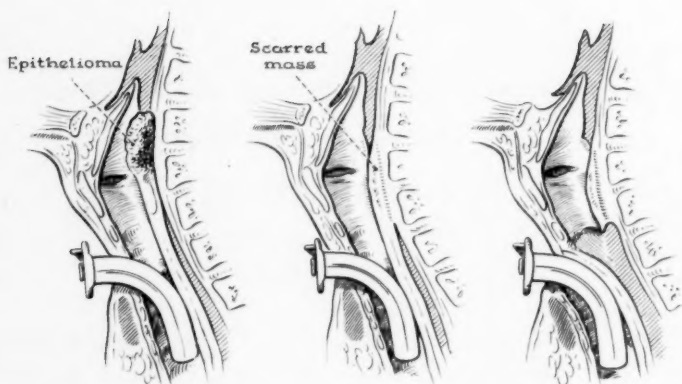


Fig. 1 *a*.—Sagittal section of the larynx. Patient had a huge malignant tumor (squamous cell epithelioma, grade 3) of the hypopharynx arising from a broad base in the right arytenoid region, the right aryepiglottic fold and the vallecula. Tracheotomy has been performed to relieve laryngeal obstruction. *b*. Sagittal section of the larynx after treatment. The epithelioma was treated by fractional x-ray therapy and interstitial irradiation with radon seeds. The treatment completely eradicated the growth but resulted in sequestration of a large part of the cricoid cartilage and almost complete stenosis of the esophageal introitus as illustrated. *c*. Sagittal section of the larynx. Since the vocal cords were fixed in complete abduction with the glottis widely open, the trachea was detached from the lower end of the larynx and brought out through the neck as in the tracheal stoma of a laryngectomy. The esophagus was then opened below the area of stenosis and the cut edge sutured to the lower margin of the laryngeal mucous membrane. By this technique the larynx was transformed into the upper end of the esophagus.

Clinic in August, 1951. On mirror examination of his larynx, I found that he had a huge malignant tumor of the hypopharynx and larynx with a metastatic node in the right midcervical region (Fig. 1 *a*). Due to the size of this growth, the airway through the larynx was markedly obstructed causing noticeable dyspnea. Except for the presence of this tumor, the general physical condition of the patient was satisfactory.

Without further delay, tracheotomy was performed to relieve the shortness of breath. The tracheal cannula was inserted through the second and third tracheal rings. Subsequently, the pharynx and larynx were thoroughly examined under suspension laryngoscopy. The growth was found to be extremely large and pedunculated, arising from a broad base in the right arytenoid region, the right aryepi-

glottic fold and vallecula. A specimen removed for microscopic examination was diagnosed as a squamous cell epithelioma, grade 3.

Due to the involvement of the lateral wall of the pharynx and the presence of a metastatic cervical node, electrocoagulation together with interstitial and external irradiation was thought to offer as good a prognosis as pharyngectomy combined with laryngectomy. With this decision in mind, I proceeded to destroy the tumor by electrocoagulation under suspension laryngoscopy. Eleven radon seeds each worth one millicurie were implanted into the electrocoagulated base, and an attempt was made to distribute them evenly throughout the involved tissue. In addition, seven seeds, valued also at one millicurie each, were inserted into the metastatic node in the right midcervical region. Two days later, the patient was sent to the Section of Therapeutic Radiology for fractionated x-ray therapy. A total dose of 2,250 r was given to each side of the neck over a period of 15 days. Due to the intensity of the treatment, edema in the mucosa of the hypopharynx and larynx developed promptly so that swallowing was impossible. Consequently, a rubber feeding tube was inserted through the nose to the stomach. On completion of the radiation therapy, the patient was permitted to go home with the tracheal cannula and feeding tube in place.

Because of postradiation edema, the patient still was unable to swallow three months after operation. With the passage of another three months, it was evident that the persistent dysphagia in this case was due to perichondritis. As a matter of fact, a large piece of sequestered cricoid cartilage was removed under suspension laryngoscopy at this time. Unfortunately, the perichondritis resulted in complete stenosis of the esophageal introitus (Fig. 1 *b*). In addition, scar tissue in the arytenoid regions pulled the vocal cords widely apart, a complication which later proved to be extremely beneficial. The patient continued to take nourishment through the feeding tube. Eighteen months following the operation, a thorough examination of the patient's throat and neck revealed no recurrence of the carcinoma. Because dysphagia still was complete, I decided that some surgical procedure should be undertaken to correct the stenosis of the esophagus, so that the patient could swallow again.

At first I considered performing laryngectomy, resecting all of the cicatricial tissue producing the stricture and attempting to rebuild the upper end of the esophagus. However, such a reconstruction not only would have been extremely involved but I was fearful

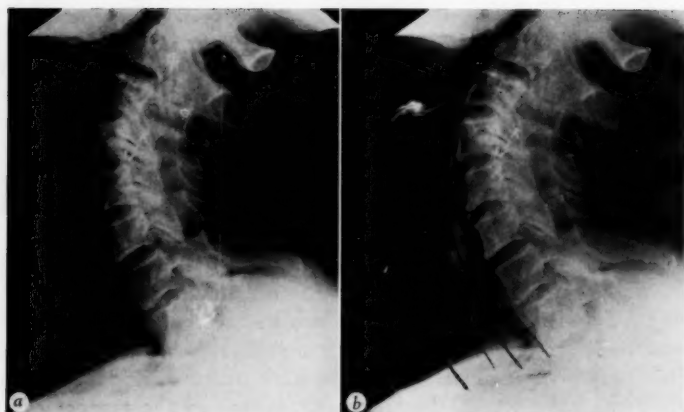


Fig. 2.—Patient whose condition is illustrated in Figure 1. X-rays were taken 4 months after the surgical procedure which attached the larynx to the esophagus as illustrated in Figure 1 *c*. *a*. The lumen through the larynx into the esophagus is visible; also the tracheal lumen which opens externally. *b*. Same as *a* with the tracheal, laryngeal and esophageal lumina outlined for clarity. Since the operative procedure illustrated in Figure 1 *c*, the patient has swallowed satisfactorily through the larynx into the esophagus for the past three and one-half years, and there has been no evidence of recurrence of the laryngeal carcinoma for almost five years.

that healing of the wound might be delayed or unsatisfactory because of radiation changes in the tissues. In view of the fact that the vocal cords were fixed in complete abduction with the glottis widely open, everything which the patient swallowed emptied directly into the larynx. Consequently, I decided to detach the trachea from the lower end of the larynx and to connect the esophagus to the laryngeal mucosa; this would transform the larynx into the upper end of the esophagus (Fig. 1 *c*).

Accordingly, the larynx was opened through a laryngofissure after which the trachea was severed from the larynx by a horizontal incision across the upper end of the windpipe. The trachea was freed downward from the surrounding tissues for a distance of 3 cm. with blunt dissecting scissors. The free edge of the trachea then was sutured to the surrounding skin to make a tracheal stoma similar to that made whenever any laryngectomy is performed. Furthermore,



separation of the trachea from adjoining structures exposed the underlying esophagus to full view. It was then a simple procedure to prepare a horizontal incision in the esophagus just below the area of stenosis. Subsequently, the cut edge of this esophageal incision was sutured to the lower margin of the laryngeal mucous membrane to complete the connection between the esophagus and pharynx. Strap muscles were sutured together in the midline as was the vertical incision in the skin.

Three and one-half weeks after operation, the wound was entirely healed, and the patient could swallow well enough so that the rubber feeding tube could be removed. It was necessary, of course, for the patient to take small bites and chew his food thoroughly, but passage of the bolus of food through the wide-open glottis in the larynx presented no difficulties.

In four months, the patient gained 40 pounds and could swallow any type of well-masticated food. Three years have now elapsed since the larynx was connected to the esophagus. The patient still swallows satisfactorily, and has had no recurrence of the carcinoma (Fig. 2).

#### COMMENT

While this case presents a rather peculiar set of circumstances in that the vocal cords were held widely apart by scar tissue so that food could pass easily through the larynx, I think that the surgical technique employed on this patient might be considered occasionally for other individuals with severe cicatricial stenosis or a carcinoma of the esophageal introitus. If the vocal cords were not abducted, it would be necessary to do submucous resection of tissues forming the vocal cords in order to create a large open glottis through which food could pass. Moreover, excision of that portion of the epiglottis which projects into the pharynx would also be of help in effecting a more direct passage for food from the pharynx into the larynx.

MAYO CLINIC

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# The Scientific Papers of the American Broncho-Esophagological Association

LXIX

## CONTACT ULCER OF THE LARYNX

CHARLES C. WOLCOTT, M.D.

BRONXVILLE, N. Y.

"Superficial erosions are not uncommon in chronic laryngitis, but there is a shallow ulcerative lesion that is deserving of a special designation and a particular recognition because it is so frequently either overlooked altogether in the milder cases, or mistaken for tuberculosis or malignant disease in the case of larger lesions."

This was written by Dr. Chevalier Jackson<sup>1</sup> twenty-eight years ago and the lesion was named "contact ulcer of the larynx."

The lesion is not common, Jackson saw only 127 cases in 40 years. Baker<sup>2</sup> reported 19 cases seen in 16 years. It is much more prevalent in males.

Many factors, as chronic upper respiratory infection, excessive use of tobacco and alcoholic beverages, irritative industrial environment and vocal abuse have been considered as having etiological relations. Of all these, vocal abuse is now believed to be the chief cause with the other factors being contributive or aggravative.

Vocal abuse is a variable term in that it produces different pathology in different individuals. It may be voluntary abuse or it may be involuntary.

One of my patients, a member of the diplomatic corps, was sent abroad on a very urgent mission. For a month he attended meetings every day and late into the night, often under much stress. He returned to America with an acute contact ulcer which healed following vocal and physical rest.

This was a typical case of contact ulcer resulting from voluntary vocal abuse.

Involuntary vocal abuse occurs in the individual who has what Dr. Jackson termed "a throaty voice." This is called involuntary because it is the person's normal method of voice production. It is a voice of low pitch and intensity, it projects poorly and fatigues easily.

A person with such a voice may use it for years without developing any pathology. Yet, under certain conditions and with no awareness on his part of any increase in vocal demands, he can develop a contact ulcer of the larynx which will be much more refractory to any treatment than the voluntary type.

Vocal abuse seldom produces an ulcer in a person with a soprano voice or even a tenor voice, but it will produce a vocal nodule. The lower the pitch the less likelihood of a vocal nodule occurring. A nodule is extremely rare in a bass voice.

Five cases, four men and one woman, other than the one cited above were seen in the last four years, who developed contact ulcers, the cause of which was obscure. There had been no change in their vocal demands. Tobacco, alcohol and chronic infection were not factors. Their ages were from 35 to 51 years.

The first case was a dentist, 50 years old, seen in 1952. He had experienced vocal discomfort for three months, often with pain over the left side of the larynx radiating to the left ear. Mirror examination revealed a swollen inflamed left arytenoid with superficial ulceration about the left vocal process. His tonsils had been removed several years before and roentgen examination of the sinuses was negative. His natural speaking voice was of low pitch, intensity and placement, a typical throaty voice.

He was placed on vocal rest, steam and penicillin powder inhalations. After two weeks the only change was a reduction in ear discomfort. He was sure he had a malignancy and asked for a direct laryngoscopy. This was done and no new information was obtained. He decided to take a vacation by himself for a complete vocal rest. He went to Canada on a fishing trip and conversed about five minutes a day. He returned after three weeks and examination revealed considerable improvement. He then consented to try vocal instruction, but gave it up after one month. Laryngeal examination at this time showed a healed ulcerated area but swelling and some inflammation of the left arytenoid persisted. He found that, talking very little, avoiding meetings and social contacts reduced his discomfort considerably. About three months later he returned with all symptoms much aggravated and complaining also of gastric distress which was relieved by eating. He revealed that he was very much perturbed by a certain situation at home and I advised him to consult his family physician. He did so, and was placed on an ulcer diet and given an anticholinergic drug. He reported to me after two weeks that his laryngeal symptoms were much improved. Mirror examination showed marked improvement. He continued the above regime for two weeks and a complete cure resulted. His domestic situation was eventually re-

solved satisfactorily and he has remained asymptomatic most of the time. I examined him recently and he has a normal larynx. He has had occasional discomfort which is easily controlled by one or two days' use of the anticholinergic medicine.

During the time I was treating this patient, I had under my care a member of an advertising firm who had a contact ulcer with a granuloma. This was removed by direct laryngoscopy. The patient was then given the same remedy and complete healing occurred promptly. However, he had several mild recurrences of throat discomfort with hoarseness which were controlled by the medication. In April 1956 after an interval of two years he reported to me with a contact ulcer and small granuloma. He went to Florida for a short vacation. During this time, he took the medicine regularly and refrained from talking except at meal times. Examination on his return showed very little improvement. He agreed to take vocal instruction which he followed in every detail. He continued his medicine twice daily. I examined his larynx five days ago. The granuloma has disappeared and healing is nearly complete.

The other three cases were given the medical treatment only and responded most satisfactorily.

These five cases presented some very interesting similarities.

1. All, including the woman, had the typical throaty voice. To them it was their normal voice, but under stress it constituted vocal abuse. Each had talked many years this way, yet developed contact ulcers eventually without being aware of any unusual vocal demand.

2. In each case there had been an increase in stress either physical or emotional. This, plus their faulty vocal production, seemed to be the factors causing development of pathology.

3. In all the cases which were right handed the left arytenoid area revealed more pathology. One case, the woman, was left handed and her ulcer was on the right cord.

This seems to suggest that, under stress, in right-handed persons the right cord becomes what Dr. Jackson termed the hammer and inflicts trauma to the left cord or anvil. If left-handed, the opposite condition occurs. If the action is prolonged, the hammer may also become involved.

This is, admittedly, a small series. However, I believe the role of stress is a major one in cases of contact ulcers in patients who do not wilfully abuse their voices but who have faulty vocal production as outlined above.

This stress causes excessive neural stimulation of the parasympathetic nervous system which excites the vagus nerves supplying both vocal cords. This results in increased strength and excursion of the cord action causing the traumatic hammer and anvil effect.

If a nerve blocking drug could be found to reduce this action, trauma would be reduced or eliminated and healing occur. Anticholinergic drugs have such a ganglionic blocking action. Their action on the vagus nerves, reducing alimentary hyperactivity is well known.

There are several such drugs available. The one that proved most efficacious was methanthelene bromide. It has some side effects which should be noted. One is xerostoma or dryness of the mouth. Another is mydriasis which may blur near vision. The drug should not be administered to patients with glaucoma. Urinary retention may occur in patients with prostatic hypertrophy.

The usual dosage is 50 mg before meals and at bedtime. As improvement occurs the frequency is reduced but continued until healing is complete.

#### SUMMARY

The most refractory type of contact ulcers of the larynx occurs in individuals with the so-called throaty voice who are subjected to emotional stress. Ganglionic blocking drugs will provide a marked relief of symptoms and often effect a cure. If, the stress is a frequent factor in the patient's life, he should undergo vocal re-education to raise his voice placement.

The combination of the drug and vocal instruction in one of my cases resulted in the disappearance of a granuloma and healing of the recurrent ulcer in one month. This patient was seen on April 12, 1956. He stated that his new method of vocal production is much less tiring. If vocal fatigue develops and he must continue talking, one tablet will enable him to continue without discomfort or ill effect.

The role of vocal abuse is a main factor in the etiology, hence, the role of vocal re-education is a major one in preventing recurrences.

130 PONDFIELD ROAD

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## UNUSUAL BRONCHIAL TUMORS

F. EDMUND DONOGHUE, M.D.

HOWARD A. ANDERSEN, M.D.

AND

JOHN R. McDONALD, M.D.

ROCHESTER, MINN.

Prior to the advent of the bronchial biopsy, considerable inconsistency and confusion prevailed in the classification of endobronchial tumors. Time and experience have aided the pathologist in the evolution of a more standardized nomenclature and histologic classification, and with the determination of the benign or malignant nature of these tumors a workable guide to therapy has been provided. It is now unusual for a primary endobronchial tumor presenting a bronchoscopic problem to be any tumor other than a carcinoma or an adenoma. Other tumors are sufficiently few to justify reports of individual cases.

A review of the records at the Mayo Clinic for the years 1945 through January, 1956, revealed only 14 patients with these unusual endobronchial tumors among 11,626 patients who had undergone bronchoscopic examinations during this period, an incidence of one of these tumors in 830 bronchoscopic examinations. No comparable study of the frequency of bronchogenic carcinoma during this entire period is available but during the period of 1943 through 1949, Kirklin and associates<sup>1</sup> found 1,577 patients having primary bronchogenic carcinoma.

Thirteen of the tumors in our group were benign; the other was a fibrosarcoma. Bronchial adenomas, carcinomas and endobronchial tumors forming amyloid were excluded. No instance of aberrant thyroid tissue was encountered. The types of endobronchial tumors found are listed in Table I.

## HAMARTOMA

The predominance of the hamartoma over other endobronchial tumors in this series was surprising in view of the relative infrequency

Section of Medicine and Section of Surgical Pathology, Mayo Clinic and Mayo Foundation. The Mayo Foundation, Rochester, Minnesota, is a part of the Graduate School of the University of Minnesota.

of recorded occurrence of this tumor. Undoubtedly many of these tumors have been previously classified as chondromas, osteochondromas or lipochondro-adenomas, but according to the criteria of Albrecht<sup>2</sup> they are more properly classified as hamartomas. Young, Jones and associates<sup>3</sup> collected reports of 22 cases of hamartoma to which they added two of their own. Eight additional cases have been recorded in the literature,<sup>4-8</sup> making a total of 32 recorded cases as far as we could determine. We are presenting two additional cases of endobronchial hamartomas.

#### REPORT OF CASES

**CASE 1.** A man, 39 years old, was examined for the first time in March 1951, because of chronic cough and recurrent attacks of fever of ten years' duration. He had enjoyed good health until 1941 when his first attack of fever occurred. A roentgenogram of the thorax in 1935 was said to be normal, but on repetition in 1941 a mass, 1.0 cm in diameter, was detected in the region of the right upper lobe. Since then he had had two or three attacks annually of respiratory infections which gradually increased in severity and were characterized by fever, chills and cough which was productive of purulent sputum.

In January 1951 the patient experienced an attack of pneumonitis which roentgenograms showed to be localized to the right upper lobe. Bronchoscopy was performed elsewhere and was said to be negative; bronchograms revealed an absence of filling of the posterior segment of the right upper lobe bronchus. The remainder of the history yielded no significant information.

On physical examination there were no abnormal findings. Laboratory studies of his blood and urine were normal. A second-strength tuberculin test was positive. Two examinations of sputum were negative for malignant cells. A roentgenogram of the thorax disclosed an indefinite round mass, 2.0 cm in diameter, in the region of the right upper lobe and a denser circumscribed nodule, 1.0 cm in diameter, located opposite the anterior end of the third rib.

A bronchoscopic examination revealed no abnormalities; no lesion could be seen in the right upper lobe bronchus. A diagnosis of indeterminate lesions of the right upper lobe was made. The lesions were suspected of being granulomas, probably tuberculomas.

A right thoracotomy was performed through the right posterior sixth intercostal space. A smooth rounded mass was palpated in the hilus of the right upper lobe and a small nodule was felt in the periphery of the right upper lobe, along the fissure between the right upper lobe and the right middle lobe. There were obvious signs of obstructive pneumonitis in the region supplied by the posterior segment of the right upper lobe bronchus. The operation was completed as a right upper lobectomy.

On pathologic examination a hamartoma of immature myxomatous cartilage was found in the right upper lobe bronchus. Distal to the tumor there was obstructive pneumonitis. There was also a single caseous and partially calcified granuloma in the periphery of the right upper lobe. Cultures removed from the granuloma were subsequently negative for tubercle bacilli and fungi.

A roentgenogram of the thorax taken six months later disclosed only changes attributed to the operation.



TABLE I  
UNUSUAL PRIMARY ENDOBRONCHIAL TUMORS

| LESION       | CASES |
|--------------|-------|
| Hamartoma    | 5     |
| Lipoma       | 4     |
| Fibroma      | 4     |
| Fibrosarcoma | 1     |
| Total        | 14    |

CASE 2. In September, 1952, a land appraiser 60 years old, sought treatment for a thoracic lesion discovered in a roentgenogram one week before admission. He had been in good health until six weeks before admission, when an upper respiratory infection accompanied by fever, pharyngitis and cough developed. The acute symptoms subsided in two weeks but the cough persisted.

On physical examination there were no abnormal findings. Laboratory studies of his blood and urine gave normal results except for a sedimentation rate of erythrocytes of 47 mm in one hour (Westergren). Sputum studies of two specimens for malignant cells and of one for acid-fast bacilli were negative. A roentgenogram of the thorax revealed an ill-defined mass located at the left hilus with obstructive pneumonitis which extended peripherally in the anterior segment of the left upper lobe of the lung.

On bronchoscopic examination the left upper lobe bronchus as well as the remaining bronchi appeared normal. A left thoracotomy, performed three days later, revealed pneumonitis limited to the area of the anterior segmental division of the left upper lobe bronchus. The operation was completed as a left upper lobectomy.

In the surgically removed specimen, occluding the anterior segment of the left upper lobe bronchus, was a polypoid endobronchial hamartoma, measuring 1.0 by 0.9 by 0.6 cm. The tumor was composed of a central core of cartilage and a rim of fatty tissue. The peripheral portion of the involved segment of the left upper lobe contained a region of massive obstructive pneumonitis.

Recovery was uneventful and when the patient was examined 18 months later, the only untoward change noted in the roentgenogram of the thorax was a residual pleural thickening at the base of the left lung.

#### LIPOMA

Histologically lipomas are closely related to fibromas: some fibrous tissue is present in most lipomas, and conversely fibromas frequently contain small amounts of adipose tissues. The predominant tissue present determines the classification of the tumor. If significant amounts of each type of tissue are present, the tumor is then classified as a mixed tumor such as a lipofibroma or fibrolipoma. The tumors included in the series have been classified histologically according to the predominant type of tissue present and no tumor contained a



sufficient quantity of another tissue to justify classification as a mixed tumor.

In four cases primary endotracheal or bronchial lipomas were found. Two of these tumors extended through the bronchial wall, the larger endobronchial portions connecting with the extrabronchial extensions forming dumbbell-shaped tumors. One of these cases is presented.

CASE 3. A man, 51 years of age, was examined in January 1956. He had experienced chronic cough for 20 years and had had three attacks of pneumonia in the past 6 years. At the time of his last attack in 1953, he was told that his left lung had completely collapsed. Bronchoscopic examinations were performed elsewhere, and he was informed that a benign tumor was removed from the left bronchial tree. Following the second bronchoscopic procedure, mediastinal and subcutaneous emphysema developed and extended from his head to the anterior and lateral portions of his thorax. He experienced respiratory distress and fever for several days and was confined to a hospital for approximately two weeks. Hemoptysis continued for three months. His cough improved but gradually returned to its former degree of severity in the next 18 months.

On physical examination at the clinic scattered medium-sized rales were heard at the base of the left lung posteriorly and an inspiratory wheeze could be heard over the entire left lower part of the chest.

Laboratory studies of blood and urine were normal. A roentgenogram of the thorax appeared normal except for an adhesion to the dome on the left side of the diaphragm.

Bronchoscopic examination revealed a large reddish-yellow conical tumor arising from a wide base, attached to the anterior wall of the left main bronchus, approximately 1.5 cm from the carina tracheae. The tumor was rubbery and was apparently completely covered with bronchial mucosa, there being no areas of ulceration. The tip was flattened slightly, and there the mucosa was of a lighter color. Tissue was removed as a biopsy but only bronchial mucosa was obtained. No attempt to remove the entire tumor was made as the base covered at least 25 per cent of the circumference of the bronchus. The risk of serious hemorrhage and bronchial perforation was considered excessive. Transthoracic surgical removal was advised.

When the surgeon opened the left thoracic space, a firm tumor could be palpated in the left main bronchus adjacent to the carina tracheae. It had a large intrabronchial and a small extrabronchial component. Transbronchial excision presented a great risk as the area was immediately against the pulmonary artery and close to the carina. Pneumonectomy was performed.

The pathologic diagnosis was endobronchial lipoma which involved all the layers of the bronchial wall and had a small extrabronchial component.

#### FIBROMA

Fibromas, according to the total number of reported instances of these tumors, occur with the same approximate frequency as lipomas.<sup>9</sup> In this series there were four endobronchial fibromas. A representative case is presented.

CASE 4. An executive, 42 years old, from South America was examined in September 1955. He complained of recurrent attacks of fever of nine months' duration. During these attacks his temperature usually reached 105° F. and was accompanied by chills and sweats. A chronic cough productive of one to two ounces of yellow-green sputum daily had been present for ten years. He had ceased smoking one year before examination without improvement of his cough. Episodes of hemoptysis began nine months before and continued for approximately three months. He had lost 15 pounds during the past nine months.

On physical examination ronchi and asthmatic wheezing could be heard over the entire chest. Laboratory tests showed a normal hemogram except for eosinophilia of 6 per cent. The sedimentation rate of erythrocytes was 8 mm in one hour (Westergren). Smears of two specimens of sputum were negative for acid-fast bacilli as was a smear for malignant cells.

A roentgenogram of the thorax disclosed increased pulmonary markings at both bases suggestive of bronchiectasis, and an ill-defined lesion was present anteriorly at the level of the left second intercostal space.

Bronchoscopic examination revealed a pedunculated tumor arising from the posterior and lateral walls of the left main bronchus. The tumor was completely covered with bronchial mucosa. Multiple biopsies revealed only bronchial mucosa with areas of squamous metaplasia.

Four days later bronchoscopic examination was repeated and the tumor was photographed with a Holinger-Brubaker camera. The tumor was removed en masse through the bronchoscope. On inspection of the former area of attachment to the bronchus no tumor tissue remained and there was a minimal amount of bleeding. The pathologic diagnosis was endobronchial fibroma, 1.3 cm in diameter.

Within the subsequent two weeks of observation prior to his return home, the patient's cough decreased greatly.

#### FIBROSARCOMA

The only unusual primary endobronchial tumor that was malignant in our cases was a fibrosarcoma. A primary pulmonary sarcoma is an extremely rare tumor; in most circumstances the sarcoma is metastatic from some primary source other than the lung. Black<sup>10</sup> found five authenticated cases of primary fibrosarcoma of a bronchus and reported one case of his own; Carswell and Kraeft<sup>11</sup> reported in the same journal an additional case making a total of seven cases of primary bronchogenic fibrosarcoma.

CASE 5. Our patient was a girl, 5½ years old, who was examined in May 1951. Her parents stated that 14 months earlier the patient had a febrile illness which responded quickly to penicillin. Acute rheumatic fever was suspected, and during the succeeding 12 months several additional attacks of fever occurred, each attack responding to antibiotics. Six months before a persistent cough developed, and a roentgenogram of the chest disclosed abnormal density in the region of her right upper lobe. Bronchoscopic examination elsewhere had revealed a "benign tumor." The parents were advised to have periodic roentgenograms of the thorax made, but, as the bouts of fever and cough continued, further advice was sought. The remainder of the child's history was noncontributory.

No abnormalities were found on physical examination and laboratory studies of blood and urine gave normal results. A roentgenogram of the thorax was interpreted as showing a contracted right upper lobe.

Bronchoscopic examination revealed a polypoid tumor projecting from the orifice of the right upper lobe bronchus. The tumor was soft and movable; it bled liberally on contact and on removal of a specimen for biopsy. By histologic examination the lesion was found to be a fibrosarcoma, grade 2. Bronchial secretions aspirated at the time of bronchoscopy contained malignant cells.

Right thoracotomy was performed. The right upper lobe was collapsed, and a tumor was palpated in the right hilus. The operation was completed as a right pneumonectomy.

The lesion was a polypoid endobronchial fibrosarcoma, grade 2, measuring 2.5 by 2.0 by 2.0 cm, and arising from the right upper lobe bronchus. The bronchial wall had been eroded and the peribronchial connective tissue was superficially invaded. No hilar lymph nodes were involved. The peripheral portions of the right upper lobe contained an obstructive pneumonitis.

The patient's recovery was uneventful. No tumor other than the primary fibrosarcoma removed from the lung was found. A letter received from the patient's parents three months after her dismissal reported her to be in good health. Subsequent efforts to trace the child or family have been unsuccessful.

#### COMMENT

Endobronchial tumors are clinically important not only because of their usual malignant nature but also because of their location and obstructive capacity. A small percentage of all endobronchial tumors are benign but clinically these tumors present hemoptysis, bronchial obstruction or both and are indistinguishable from malignant neoplasms without the aid of a bronchoscopic or transbronchial biopsy. Bronchoscopic removal of benign endobronchial tumors with the preservation of bronchial continuity is the preferred procedure. When this is not possible, transbronchial removal of the tumor or lobectomy is as imperative as if the tumor were malignant. Information gained from review of the case records of the 14 patients with unusual bronchial tumors offers limited assistance in differentiating these tumors from other endobronchial growths.

#### ADDITIONAL FEATURES IN OUR 14 CASES

The ages of these patients varied from 5½ to 62 years; nine of the patients were more than 40 years of age. Ten of the patients were males, four were females of whom two were girls less than ten years of age. The duration of symptoms, consisting of chronic cough, hemoptysis or recurrent pneumonitis, varied considerably from three days to 20 years. Hemoptysis occurred in five of the patients and was the only presenting symptom in one. Evidence of obstructive pneumonitis or permanent bronchopulmonary disease arising as a result of bronchial obstruction was demonstrated in ten of the patients,

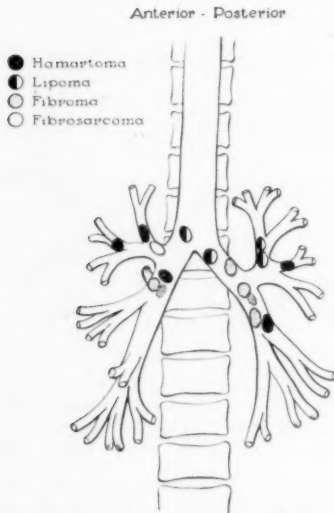


Fig. 1.—Location of primary bronchial tumors.

either by histologic examination of surgical specimens or by bronchography.

The location of the 14 primary endobronchial tumors is indicated in Figure 1. Eight of the tumors arose from bronchi of the left lung and five in the right bronchial tree. One arose immediately above the tracheal carina. Of the various tumors, marked variation was found in the distribution of the hamartomas, but the distribution of lipomas and fibromas remotely suggested a pattern. All of the fibromas were located in major bronchi and all were bronchoscopically visible. Three of the lipomas arose in the left bronchial tree and one from the lower end of the trachea. This predilection of lipomas for the left bronchial tree has been observed by McCall and Harrison.<sup>12</sup>

Ten of the 14 tumors were bronchoscopically visible (Table II). Of the ten, three were located in segmental bronchi of the upper lobes, two arose in the lower lobe bronchi, two in the left main bronchus, two in the right intermediate bronchus and one arose as a polypoid growth from the lower end of the trachea.

Only four of the tumors were removed through a bronchoscope; two of these were hamartomas and two were fibromas. Of the six tumors visible but not removable through a bronchoscope, three were

TABLE II  
BRONCHOSCOPIC AND SURGICAL PROCEDURES

| PRIMARY<br>ENDBRONCHIAL<br>TUMORS | BRONCHOSCOPY     |                  | SURGERY   |               |
|-----------------------------------|------------------|------------------|-----------|---------------|
|                                   | TUMOR<br>VISIBLE | TUMOR<br>REMOVED | LOBECTOMY | PNEUMONECTOMY |
| Hamartoma                         | 3                | 2                | 3         | 0             |
| Lipoma                            | 2                | 0                | 2         | 1*            |
| Fibroma                           | 4                | 2                | 1         | 0†            |
| Fibrosarcoma                      | 1                | 0                | 0         | 1             |
| Total                             | 10               | 4                | 6         | 2             |

\*Transtacheal removal of one additional lipoma.

†Operation refused.

located in segmental branches of the upper lobes and were not accessible. Two of the fibromas and one lipoma arose from broad bases necessitating too excessive destruction of the bronchial wall for complete removal. Transthoracic surgical removal was necessary in nine of the patients, six requiring a lobectomy, two a pneumonectomy, and one a transtacheal removal. Permission for surgical removal was refused by the parents of one child. In three patients the presence of an endobronchial tumor was discovered at lobectomy.

With one exception, transbronchial removal of the tumor was not expedient in the cases surgically treated either because of permanent bronchopulmonary disease peripheral to the tumor or because of the inaccessibility or malignant nature of the tumor.

#### SUMMARY

The results of a study of 14 unusual bronchial tumors consisting of hamartomas, lipomas, fibromas and a fibrosarcoma are presented clinically. These tumors are indistinguishable from other endobronchial tumors without the aid of biopsy. Ten of these tumors were bronchoscopically visible but only four could be removed through a bronchoscope. Two instances of extrabronchial extension of the tumor were found among the lipomas. When a benign lesion could be demonstrated and its size or bronchial attachment presented no excessive risk to the patient, bronchoscopic removal was justified. Frequently, however, the tumor was located out of reach of biopsy or resecting forceps or sufficient pulmonary damage had occurred to make surgical excision advisable.

MAYO CLINIC

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## DIVERTICULA OF THE ESOPHAGUS

DANIEL C. BAKER, JR., M.D.

NEW YORK, N. Y.

Diverticula are a fairly common disorder of the hypopharynx and esophagus. They are important because of the symptoms they produce and their systemic effect on the individual. Diverticula are increasing in number due to the longer span of life. The latter allows for more individuals to develop disorders which are more frequent in the sixth and seventh decades and which are associated with herniation of mucosa through a weakness in a muscular wall. This presentation will consider the classification, symptoms, diagnosis and therapy in 100 consecutive cases of diverticulum of the esophagus seen over an eight-year period.

## CLASSIFICATION

There has been an increasing tendency to classify diverticula according to their location. The term traction diverticulum has been given to most pouches in the midesophagus irrespective of the nature of the forces producing them. Jackson and Jackson<sup>1</sup> advocate the use of "thoracic esophageal diverticulum" and Palmer<sup>2</sup> uses the term "midesophageal diverticulum." Their classifications are based on anatomic regions rather than the forces producing the lesion.

In this presentation the term traction diverticulum is employed for pouches other than the pulsion type because it is the classification used by the radiological and surgical services at Presbyterian Hospital.

In the hypopharyngeal group there were 23 males and 15 females. The remaining cases in the middle and lower esophagus were evenly distributed from the standpoint of sex.

The average age in the Zenker type was 58 years. For all other types the average was 51 years. The lower age group of the latter is explained by the fact that the diverticula in the middle esophagus were found more frequently in the fourth and fifth decades.

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From the Department of Otolaryngology, Columbia-Presbyterian Medical Center, New York, N. Y.



## ETIOLOGY

Hoover<sup>3</sup> and Jackson and Jackson<sup>1</sup> have discussed the factors that may produce a diverticulum of the hypopharynx. The disorder is a herniation of pharyngeal mucosa through the inferior constrictor muscle. Hoover states that the resistance to the passage of food from the pharynx through the cricopharyngeus into the esophagus along with intrapharyngeal pressure are important factors. Jackson and Jackson<sup>1</sup> believe that an atavistic weakness in the muscular support of the hypopharynx may exist. The latter in addition to failure of the cricopharyngeus to relax along with contraction of the inferior constrictor puts pressure on the hypopharyngeal wall. The herniation takes place at the point of atavistic weakness.

Age and sex are contributing factors. The condition occurred more frequently in men and in this group the average age was 58 years.

Traction diverticulum is the term given to the pouches found in the thoracic esophagus with the exception of the epiphrenic or pulsion diverticula of the lower esophagus.

The traction type of diverticulum that occurs in the midesophagus rarely produces clinical symptoms.<sup>4</sup> It is due to contraction from fibrosis brought about by inflammatory disease of the outer wall of the esophagus. There is usually disease in the lymph nodes at the tracheal bifurcation and hilar regions that become adherent to the esophagus. There may be other factors causing diverticula in the middle and lower esophagus such as increased intraluminal pressure or weakness of the muscular walls. In some instances, neither pulsion or inflammatory disease appeared to be factors.

Clerf and Putney<sup>4</sup> reported seven cases of epiphrenic esophageal diverticulum. This is a pulsion type which is brought about by pressure from within and is a herniation of the mucous membrane through the muscle coat. The pouch occurs in the lower third of the esophagus usually close to the hiatus. A histologic study of the layers of the sac showed the muscle layer to be thin and sparse with weakness of this layer. They found the sympathetic nerve ganglia to be intact.

In the group of cases presented, there were five patients with epiphrenic diverticulum. In one patient there was a hiatal hernia. Holinger<sup>5</sup> found that six of his eight cases of epiphrenic diverticulum had an associated hiatal hernia. Goodman and Parnes<sup>6</sup> found a definite relation between epiphrenic diverticulum and achalasia.



TABLE I  
FINDINGS IN 100 CONSECUTIVE CASES OF  
DIVERTICULUM OF THE ESOPHAGUS

| LOCATION | NUMBER | TYPE                        |
|----------|--------|-----------------------------|
| Upper    | 38     | Hypopharyngeal (Zenker)     |
| Middle   | 37     | Traction                    |
| Lower    | 25     | Traction—20<br>Epiphrenic—5 |

## SYMPTOMATOLOGY

In diverticulum of the hypopharynx, dysphagia is usually an early symptom. Noisy swallowing is a frequent complaint and the patient may state that he hears the noise after he has swallowed. Pressure on the lower anterior neck may give the sensation of crepitus due to bubbles of air mixed in the fluid of the sac. Cough is usually present and may be troublesome. The patient may regurgitate undigested food particles hours after they have been ingested. As the sac increases in size, the dysphagia and cough become more pronounced.

TABLE II  
SYMPTOMS PRESENT

| TYPE                    | NUMBER    |
|-------------------------|-----------|
| Hypopharyngeal (Zenker) | 38 (100%) |
| Traction                | 10 ( 27%) |
| Epiphrenic              | 5 (100%)  |

Traction diverticula and thoracic diverticula rarely give rise to symptoms. Usually the sac is small and has a wide mouth. The sac is easily emptied and rarely is food retained. In the majority of instances the traction diverticulum is discovered by x-ray study. It is often difficult to find a small sac with the esophagoscope.

The symptoms that occur in patients with epiphrenic diverticula vary. The symptoms may be incidental or related to other factors, namely, achalasia or hiatal hernia. As the sac increases in size, symptoms of obstruction develop. The patient may complain of epigastric distress, loss of weight and regurgitation.

TABLE III—DIAGNOSTIC ESOPHAGOSCOPY

| TYPE                    | NUMBER    |
|-------------------------|-----------|
| Hypopharyngeal (Zenker) | 15 ( 41%) |
| Traction                | 10 ( 27%) |
| Epiphrenic              | 5 (100%)  |

## DIAGNOSIS

A careful history will usually give a clue as to the diagnosis. Roentgen examination of the esophagus is the most important diagnostic study. Esophagoscopy is particularly important in the study of epiphrenic diverticula. Care should be exercised in passing the esophagoscope because the tip of the tube usually enters the sac and the esophageal lumen is difficult to find. Using a previously swallowed string as a guide to the lumen of the esophagus is very important.

Esophagoscopy should probably be performed in all patients with diverticula. One patient in the group had an intramucosal carcinoma in the sac. Another had a stricture in the midesophagus below a Zenker's diverticulum.

TABLE IV—TREATMENT

| TYPE                    | NUMBER | SURGERY |
|-------------------------|--------|---------|
| Hypopharyngeal (Zenker) | 38     | 30      |
| Traction                | 57     | 0       |
| Epiphrenic (pulsion)    | 5      | 4       |

Clerf and Putney<sup>4</sup> have stressed the importance of insufflating air into the esophagus during examination. In epiphrenic diverticula, it is important to observe the hiatus for evidence of stenosis or other disease and also to determine the site of opening of the sac.

## TREATMENT

The treatment for hypopharyngeal and epiphrenic diverticula is surgical. Palliative therapy is not of much value because the condition persists and is progressive unless surgery is performed.

If a stricture is present below the sac, it is important to dilate it. Any esophagitis must be treated with diet and medication.

The traction diverticula in the series did not require any specific treatment.

Not all of the patients received the benefit of surgery. In some the presence of other more serious illnesses such as carcinoma, cardiovascular and renal diseases prevented a surgical procedure.

Surgery for the hypopharyngeal diverticulum consisted of a one-stage operation. Jackson and Norris<sup>7</sup> and Shallow and Clerf<sup>8</sup> have described the technique for the one-stage procedure. The entire sac must be removed. In this series there were two recurrences. A second operation was necessary on one of these patients.

Hoover<sup>3</sup> has stressed the importance of dissecting the sac free from muscle. The neck of the sac must be exposed at its junction with the esophagus before it is amputated. Partial section of the circular cricopharyngeal fibers is of benefit in decreasing muscular tension below the sac.

In four patients with epiphrenic diverticula, surgery was performed. The results were good in three patients. In the fourth, there was a good anatomical result but the patient continued to complain of epigastric distress. Esophagoscopy showed a stenosis at the hiatus which had to be dilated. This brings up the importance of doing a myotomy of the Heller type when thickening of the muscle band is found distal to the sac. It is important that the esophagogastric junction should not be disturbed by the surgical procedure, as it may be followed by esophagitis.

#### SUMMARY

A group of 100 cases of diverticula of the esophagus are reviewed.

The etiology, symptoms and treatment of the group are discussed.

Hypopharyngeal and epiphrenic diverticula usually require surgery in order to secure a good clinical result.

Traction and thoracic diverticula usually do not cause symptoms and rarely require treatment.

903 PARK AVE.

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LXXII

THE TREATMENT OF COMPLICATIONS OF  
CARCINOMA OF THE THYROID  
INVOLVING THE FOOD  
AND AIR PASSAGES

R. W. HANCKEL, M.D.

AND

JOHN C. HAWK, JR., M.D.

CHARLESTON, S. C.

There are not a large number of cases of carcinoma of the thyroid which involve the food and air passages, but those encountered may present a variety of problems which tax the ingenuity of those handling the cases. The otolaryngologist may be called upon to assist in the diagnosis and treatment of the local complications of these lesions. It is felt, therefore, that it may be worthwhile to relate the authors' experiences with several cases presenting problems of interest to the otolaryngologist as well as the general surgeon.

The incidence of carcinoma of the thyroid was noted by Ross<sup>1</sup> in 1947 to be only 1 to 2 per cent in thyroid glands removed surgically. He referred chiefly to the Lahey Clinic analysis of 3,389 thyroidec-tomies from 1916 to 1937, in which 67 cancers were found, as incidence of 1.68 per cent. Cole et al<sup>2</sup> reported in 1945 a study of 1000 consecutive surgically treated thyroid cases in which 38 cancers were found, an incidence of 3.8 per cent. In diffuse toxic goiters (exophthalmic) in the series, the incidence of cancer was less than one per cent and in toxic nodular goiter, the incidence was 1.2 per cent. It is thus apparent that the non-toxic nodular goiter must be implicated as the chief source of thyroid cancer. Most observers report a considerably higher incidence of cancer in thyroid glands removed for solitary nodules than in multi-nodular goiters. In a collected series reviewed recently by Slaughter,<sup>3</sup> the reported incidence of cancer in solitary non-toxic nodular goiters ranged from 10.0 per cent<sup>4</sup> to 24.5

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From the Departments of Surgery and Otolaryngology and the Cancer Clinic of the Medical College of South Carolina and the Roper Hospital, Charleston, South Carolina. This study was supported in part by an Undergraduate Training Grant from the National Cancer Institute, National Institutes of Health, U. S. Public Health Service, Bethesda, Maryland.

per cent,<sup>5</sup> while the incidence of cancer in all non-toxic nodular goiters ranged from 3.8 per cent<sup>6</sup> to 17.3 per cent.<sup>7</sup> It is obvious that the possibility and even likelihood of cancer should be taken into consideration by the surgeon when operating on a non-toxic nodular goiter (especially a solitary nodule) so as to be prepared to extend the scope of operation as necessary in order to avoid a secondary procedure which, at best, is never wholly satisfactory in the treatment of cancer.

A detailed description of the anatomy of the thyroid gland is beyond the scope of this paper. Suffice it to say that since the gland is so intimately in contact with the food and air passages and the recurrent laryngeal nerves, there is necessarily frequent extension of cancer of the thyroid into these structures. It is with these complications that this paper is concerned.

#### PATHOLOGY

Although all varieties of thyroid cancer may by local extension produce involvement of the food and air passages, there are distinct differences in the characteristic behavior, and consequently in the mode of handling, of the various histologic types of thyroid cancer. Numerous classifications of thyroid cancer have been given by various authors.<sup>8-11</sup> For purposes of convenience they may be separated into the following major groups:

1. Follicular or alveolar
2. Papillary
3. Undifferentiated

The follicular type may so nearly reproduce normal thyroid that it is often difficult to make a conclusive diagnosis of cancer in the absence of metastasis or histologically-demonstrated vein invasion. Distant metastasis by the vascular route may occur very early in the course of the disease, so that metastatic foci may be recognized before the primary site is detected. In the very low-grade lesions of this variety, the prognosis for longevity may be good, even in the presence of metastases, while in the more active adenocarcinomas, the progress of the disease may be more rapid.

The papillary variety is likely to metastasize via the lymphatics in a high proportion of cases. Frazell and Foote<sup>12</sup> report that in 182 radical neck dissections for papillary thyroid carcinomas there was an overall cervical node involvement rate of 84.6 per cent, including involvement in 61.2 per cent of cases clinically negative for node metastasis. Because of the relatively favorable prognosis for survival in the low-grade papillary carcinomas, there is still some difference of

opinion as to the advisability of performing radical surgery for all papillary thyroid carcinomas. Since metastatic spread is largely lymphatic, control of the disease in the neck by surgery, with or without other therapeutic media, should theoretically be attended by a high percentage of actual cures.

The undifferentiated thyroid carcinomas fortunately form the smallest group numerically (17 per cent of Warren and Meissner's 198 cases),<sup>8</sup> but because of their aggressive features may produce the greatest number of serious complications and usually are least amenable to therapeutic measures. In these cases only temporary palliation may be achieved, but their frequently unpredictable behavior should make one guard against a defeatist attitude.

#### DEGREE OF INVOLVEMENT

The type and degree of local involvement of the food or the air passages, and the presence or absence of distant metastasis will necessarily influence the plan of treatment in any case. Four categories of local involvement may conveniently be recognized, and each may or may not be associated with distant metastasis:

1. *Compression only:* This may occur as the result of neoplasm growing around the trachea or esophagus. Usually, however, it is associated with thyroid enlargements, either benign or malignant, occurring in or near the thoracic inlet, so that the flexible esophagus and less flexible trachea are compressed by enlarging thyroid tissue between relatively rigid and fixed boundaries. Obstructive symptoms may be spontaneously alleviated at times when, with the act of swallowing, the thyroid mass rises out of the superior strait, but then fails to return because of its own bulk. Simple removal of the thyroid mass may usually be accomplished in any case of compression without invasion and relieves completely. Emergency tracheostomy is seldom necessary, but definitive surgery on a semi-emergency basis may occasionally be required as is illustrated by the following:

CASE 1. W.E., 66 year old white male, was referred to the Cancer Clinic on July 23, 1951, having been handled previously as a private patient by one of the staff members. In December 1949 the patient had noticed the appearance of a firm lump in the left side of his neck, soon followed by symptoms of dysphagia and some dyspnea, apparently due to tracheal obstruction. In April 1950 left total lobectomy and resection of a portion of the right lobe and isthmus of the thyroid were carried out. As shown in Figure 1, the preoperative deviation and compression of the trachea were relieved by the procedure. Pathologic study showed a 6 cm nodule in the left lobe which was reported at this time as "adenoma, malignant, of thyroid." X-ray therapy was given, 3100 r to each side of the neck. The patient was rehospitalized in May 1950 with a diagnosis of erythema multiforme, and was discharged after a long course 40 days later.

In May 1951, the patient noticed increased dyspnea and some pain on motion of his neck. A mass became palpable and visible at this time. In June 1951 the patient

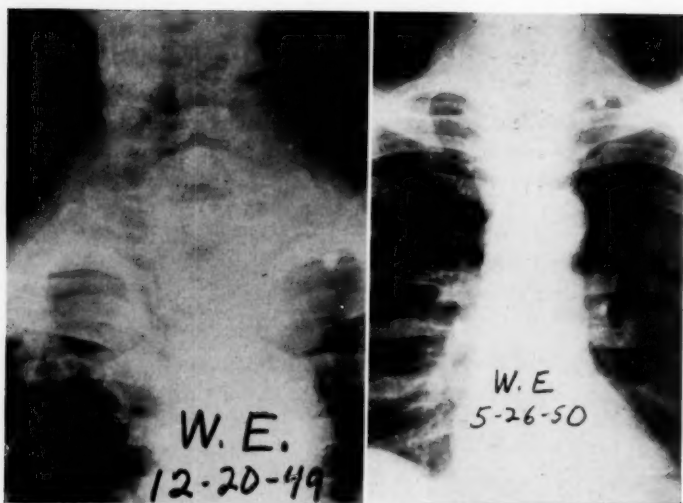


Fig. 1.—W.E. (Case 1). Note deviation and compression of trachea in preoperative x-ray taken 12-20-49 (left). Subtotal thyroidectomy performed 4-5-50. Postoperative x-ray on 5-26-50 (right) shows return of trachea to midline with less compression.

was readmitted to the Roper Hospital because of obstructive symptoms. At operation on June 11, 1951 tumor was found to be adherent to the trachea and esophagus. Resection of a portion of the right lobe of the thyroid, the lower one-third of the left sternocleidomastoid muscle, the left internal jugular vein, and the greater portion of the mass on the left side of the neck was carried out. The trachea was thus decompressed. A more radical procedure was not attempted as pulmonary metastases were demonstrable at this time. Radioactive iodine was given in doses which would now be considered small, 15 millicuries on June 20, 1951, and 40 millicuries on September 24, 1951. Additional x-ray therapy was given from July 23, 1951, to September 3, 1951, 1500 r to each right and left oblique lower cervical part.

Carcinoma began to fungate through drainage points in the incision in July 1951, and despite the above radiation therapy, progressed rapidly in size. They were removed with the electrocautery on several occasions, and bleeding controlled as well as possible. Further oozing occurred repeatedly. The patient's appearance on October 8, 1951, is shown in Figure 2. Microscopic sections of tissue removed at the second operative procedure, June 1951, showed anaplastic carcinoma with numerous tumor giant cells and mitoses. After a downhill course, the patient expired on November 3, 1951.

*Comment.* Effective decompression with relief of obstructive symptoms was obtained both at the initial operation April 5, 1950, and at the subsequent procedure June 11, 1951. It is interesting to note that the lesion was initially diagnosed as malignant adenoma of the thyroid gland, relatively well-differentiated, as the term implies, but at the time of the second procedure showed highly anaplastic carcinoma.





Fig. 2.—W.E. (Case 1). Four months after second decompressing procedure, carcinoma is seen fungating through skin.

2. *Recurrent laryngeal nerve involvement:* In these cases the diminution in vocal cord excursion may be gradual, but the patient may feel, on the other hand, that a rapid alteration has occurred, often producing a sensation of choking. Unilateral vocal cord paralysis is usually not seriously disabling, resulting only in moderate hoarseness without significant obstruction. Its presence will, of course, make the problem of the surgeon more acute, as the necessity for preserving and protecting the contralateral nerve is thus magnified. Surgically-produced vocal cord paralysis is most regrettable when it occurs in the performance of thyroidectomy for a benign goiter. When definite carcinoma is present, on the other hand, the surgeon may feel that sacrifice of a recurrent nerve is justifiable if adherence to this structure is the only factor standing in the way of an otherwise complete extirpation of the neoplasm. Even here there may be considerable question if the carcinoma is of very low grade and any residual foci might be likely to respond to radiation therapy.

CASE 2. N.T., 34 year old white female textile worker, was seen initially August 24, 1951 with a proven diagnosis of metastatic adenocarcinoma of cervical lymph nodes, based on biopsy performed earlier that month. Scattered pulmonary lesions had been found on routine chest x-ray in 1947 and she had frequent follow-up x-rays and multiple studies for tuberculosis and fungus disease, without establishing a definite diagnosis. Eight weeks prior to her first visit, she noted sudden onset of hoarseness and strangling sensations. Subsequent to this, biopsies were obtained.



Fig. 3.—B.B. (Case 3). Appearance of patient nine months following left radical neck dissection, thyroidectomy and laryngectomy for anaplastic giant-cell carcinoma of thyroid invading thyroid cartilage.

Positive findings on initial examination at the Medical College included left Horner's syndrome, paralyzed left vocal cord, hard nodule in the inferior portion of the left thyroid lobe, and multiple hard cervical lymph nodes. Radioactive iodine studies showed most marked pickup over what was presumably normal gland on the right side. There was moderate pickup over the chest where x-rays showed miliary metastases.

Total thyroidectomy was performed on September 8, 1951, followed by the administration of 69 millicuries of I-131 on September 29, 1951, and 55 millicuries on November 21, 1951. From December 1951 to March 1952 the patient had a stormy course because of mental disturbances believed due in part to definite skull and probable intracranial metastases, and in part to myxedema. Her mental state gradually improved with appropriate therapy. Administration of I-131 has been continued at intervals of three to six months since that time, with a total of 14 doses, varying from 28 to 90 millicuries. Since late spring, 1951, the patient has been essentially asymptomatic except for mild dyspnea. She has gradually developed secondary polycythemia, with mild cyanosis. There has been minimal progress of her cervical node metastases. Parathyroid deficiency has been readily controlled with Drisdol and 4 to 5 gm of calcium gluconate daily. She has been maintained on two grains of thyroid extract daily.

*Comment.* This patient has now had radiological evidence of extensive pulmonary metastases for over nine years. Her thyroid carcinoma was not diagnosed until left recurrent laryngeal nerve involvement directed attention to the cervical area. It is difficult to determine with certainty the part played by radioactive iodine in the long-term favorable results in this case. However, the fact that more rapid progression of the disease was apparent at the time intensive therapy was instituted suggests that radioactive iodine following total thyroidectomy has been a major factor in the palliative control of her disease.

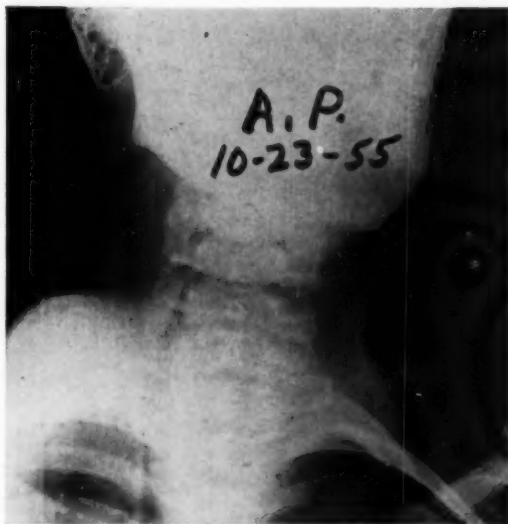


Fig. 4.—A.P. (Case 4). Trachea is deviated to right and markedly compressed, with almost complete obstruction.

3. *Attachment to laryngotrachea or pharyngoesophagus:* This may be of such minor degree that it is unsuspected preoperatively. At operation the surgeon may at time elect to dissect the neoplasm away from the attached important structure, aware that he is not obtaining an adequate margin for the eradication of cancer. This may indeed be the proper procedure for follicular and papillary carcinoma of low grade. However, if the histologic pattern is that of an undifferentiated variety, the patient's only chance for cure may be by radical surgery, preferably performed at the first operation, but frequently useful even at a later procedure.

CASE 3. B.B., 39 year old housewife, was initially referred to the Medical College Cancer Clinic June 3, 1955. She had first noted a mass in the left thyroid region three years previously, but had been otherwise asymptomatic until four months previously when she developed shortness of breath with choking sensations, dysphagia, tachycardia, and palpitation. On May 13, 1955, left hemithyroidectomy was performed in another city. At operation the upper pole of the left lobe was densely adherent to the thyroid cartilage and was removed by sharp dissection. It was the operator's opinion that carcinoma was cut across. Pathologic study showed a very anaplastic carcinoma with many tumor giant cells in some areas and spindle cells in others. There was no definite colloid production.

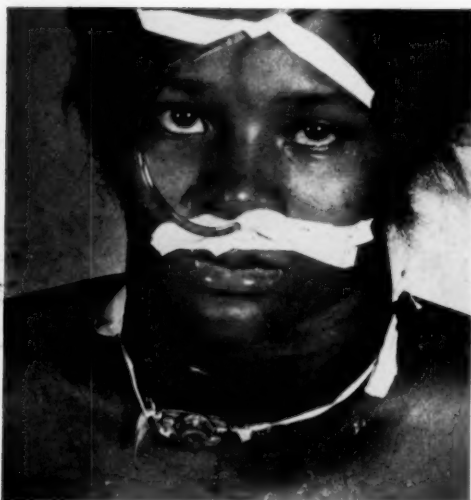


Fig. 5.—A.P. (Case 4). Shows tracheostomy tube in place to right of midline and early left Horner's syndrome.

On initial examination at the Cancer Clinic there was a healing collar incision. Irregularity and induration were palpable on the left. The trachea was not deviated. The patient was thin, and shotty lymph nodes were readily palpable in the supraclavicular, lower jugular, and spinal accessory groups bilaterally, slightly more prominent on the left. Indirect laryngoscopy showed slight limitation of motion of the left cord. Radioactive iodine uptake studies revealed 34 per cent retention I-131 at 24 hours. Concentration was approximately twice as great on the right as on the left. Chest x-ray was negative.

In view of the surgeon's report of cutting through neoplasm attached to the thyroid cartilage and the histologic appearance of the tumor (anaplastic, without colloid production) it was felt that the best chance for cure lay in radical surgery. Left radical neck dissection, laryngectomy, and completion of total thyroidectomy, en bloc, were carried out June 27, 1955. The postoperative course was complicated by left pneumothorax, which responded promptly to underwater drainage. No definite neoplastic relics were demonstrated in the operative specimen.

The patient was allowed to become moderately myxedematous, and was then given a therapeutic dose of 90 millicuries of I-131, following which she was started on thyroid extract, beginning with one-quarter grain daily and gradually increasing to her present level of one and one-half grains daily. Her appearance nine months after operation is shown in Figure 3.

*Comment.* The course of therapy described above was debated at length by the Cancer Clinic Staff and is still subject to difference of opinion. It was felt that the best opportunity for cure in her case lay in an aggressive approach. The interval since operation is too short to permit any prediction of ultimate outcome.



Fig. 6.—W.T. (Case 5). Note narrowing of trachea above tracheostomy tube in x-rays taken 8-19-53, before thyroidectomy.

If the histologic diagnosis could have been recognized accurately by frozen section at the time of her initial operation, it might have been possible to encompass all carcinoma without sacrifice of the entire larynx, but perhaps with removal of the ala of the left thyroid cartilage.

4. *Actual invasion of the food or the air passages by thyroid carcinoma:* This forms the most serious category of involvement. When the neoplasm is undifferentiated and rapidly growing only temporary palliation by surgical relief of obstruction may be achieved, as is illustrated in the following case:

CASE 4. A.P., 21 year old negro female, was referred to the Medical College Hospital as an emergency on October 22, 1955. She had noted choking sensations six months previously, but not until two months before had she noted thyroid enlargement which gradually increased. Her voice had been "weak" for two months. On October 4, 1955, operation was performed in another city, with finding of an extensively infiltrating lesion of the thyroid area. Only limited removal was attempted. The operator considered a granulomatous lesion, such as tuberculosis, the most likely diagnosis but pathologic study showed anaplastic carcinoma. The

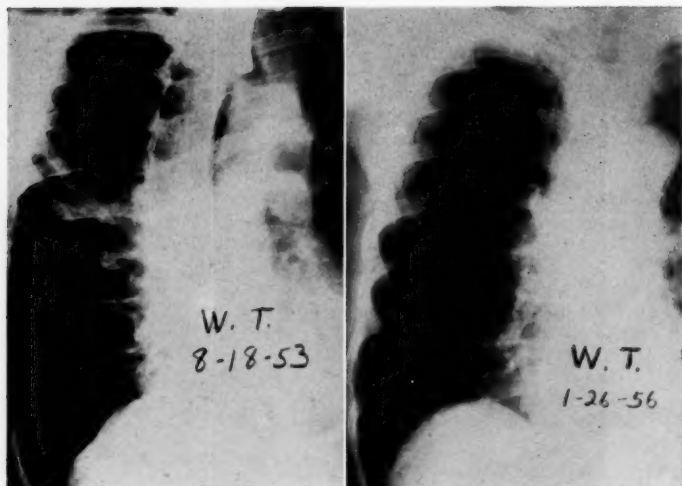


Fig. 7.—W.T. (Case 5). Small metastasis in right lung base (see arrows) has remained stable or possibly regressed in interval from 8-18-53 to 1-26-56. Note tracheostomy tube has been removed and trachea has adequate lumen, but S-shaped curve in x-ray taken 1-26-56.

patient was apparently allowed to return home after subsidence of a mild wound infection, but was re-admitted to her local hospital October 21, 1955, with respiratory obstruction, relieved only partially by aspiration of serum from the wound. She was immediately referred to the Medical College Hospital.

On admission she was in acute distress with labored respiration and marked orthopnea. The entire lower neck was occupied by a woody-hard swelling 14 cm in width and extending 10 cm above the suprasternal notch which was completely filled. Bubbling rales filled both lung fields. Slight improvement was obtained with sedation and administration of oxygen, but six hours after admission her dyspnea became so pronounced that an attempt at tracheostomy was deemed urgent. X-ray studies (Fig. 4) revealed marked deviation of the trachea to the right with extensive narrowing. Emergency tracheostomy was carried out with extreme difficulty under local anesthesia in the operating room with an anesthesiologist present. The narrowed, slit-like trachea was finally found and a Mosher life-saver inserted just as the patient appeared about to succumb from hypoxia. Replacement with a regular No. 7 tracheostomy tube was finally effected. Relief was dramatic. Microscopic sections of biopsy material showed a high grade, undifferentiated carcinoma of small-cell type. X-ray therapy was begun on October 24, 1955, directed to two 15x15 cm portals, for a total of 3000 r in air to one side and 3200 r to the other. She was given 88 millicuries of I-131. A nasogastric feeding tube was inserted and tube feedings employed to supplement her limited oral intake. A small tracheo-esophageal fistula was demonstrated on November 3, 1955, and all oral feedings were discontinued. Surprisingly, the fistula closed and oral feedings were resumed on November 21. Full supportive measures were employed including eight blood transfusions.

A left Horner's syndrome was noted for the first time on November 19. Her appearance at this time is shown in Figure 5. The response to therapy was initially satisfactory, with reduction in the size of the cervical mass. She was allowed to return home on November 26 with her tracheostomy tube in place.

Her improvement continued for two to three weeks but then regrowth of tumor at the upper margin of the treatment area was noted. Because of skin reaction, it was not feasible to give additional x-ray therapy. A dose of 100 millicuries of I-131 was given on January 14, 1956. She was subsequently re-hospitalized in her local hospital, ran a down-hill course, and died on February 17, 1956.

*Comment.* This case seemed hopeless from the start, but because of the unpredictable nature of thyroid carcinoma it was decided to treat her with all available measures. The undifferentiated nature of the carcinoma made pick-up of radioactive iodine by the tumor itself unlikely, but this was given, nevertheless, in the hope of limited benefit. This case illustrates the necessity for preoperative roentgenograms of the neck before tracheostomy is attempted in any case where a large mass is present in the neck. It would have been impossible to locate the trachea without the knowledge provided by x-ray of its marked deviation to the right. The Mosher life-saver was inserted at a time when the patient's condition was critical; probably no other instrument could have been used successfully. The full facilities of an operating room were necessary, including the presence of an anesthesiologist who administered oxygen by face mask under pressure.

In the histologically less malignant lesions, even though invasion of important structures is present, worthwhile long-term palliation may be achieved, as illustrated in the following case:

CASE 5. W.T., a 65 year old white male clerk, was first seen in the Medical College Cancer Clinic August 17, 1953, referred from another city where on June 30, 1953, he had had tracheostomy performed for respiratory obstruction. Biopsy was made of a thyroid mass and diagnosed as papillary carcinoma. He gave a history of tickling sensation and cough dating back to February 1952 and had noted hemoptysis following severe coughing on several occasions. Difficulty in breathing first took him to a physician in June 1953.

When first seen at the Cancer Clinic the patient appeared chronically ill. A tracheostomy tube was in place. A firm mass, moving with swallowing, was present in the left supra-clavicular space. X-rays of the neck (Fig. 6) revealed marked narrowing of the trachea above the tracheostomy site. Chest x-ray (Fig. 7) revealed a single small metastasis in the right base. Radioactive iodine uptake studies showed approximately low normal uptake and distribution, but slightly delayed excretion (45 per cent in 48 hours).

On August 31, 1953, operation was carried out, with findings of gross invasion of the trachea and esophagus so that total removal would have necessitated sacrifice of these structures. This was considered not advisable in the face of pulmonary metastasis. As near total thyroidectomy as was feasible was effected. The recurrent nerves were not identified. Pathologic study showed a fairly well-differentiated papillary carcinoma. Motion of the left cord was absent and that of the right slightly impaired preoperatively. This has remained unchanged. A dose of 126 millicuries of I-131 was given on September 9, 1953, the patient allowed to become myxedematous, and 75 millicuries of I-131 given December 10, 1953, despite the fact that I-131 pickup was extremely low at this time.

He was continued without thyroid extract and unfortunately developed such severe myxedema that cardiac decompensation ensued in April 1954, requiring hospi-



tal management. Small doses of thyroid extract, gradually increased to one and one-half gr daily, resulted in complete recovery. An additional dose of 80 millicuries of I-131 was given on July 31, 1954. By January 1955 he was able to keep his tracheostomy tube plugged and to phonate satisfactorily. The tube was removed and the stoma gradually narrowed. Closure was completed surgically on September 15, 1955. When last seen on April 26, 1956, his condition was excellent and no masses were palpable in the neck. Chest x-ray in January 1956 (Fig. 9) showed no change in the rounded density in the right lung base. The trachea showed an S-shaped curve in the lower neck but the lumen was adequate.

*Comment.* Near-total thyroidectomy, coupled with I-131 therapy, has resulted in a surprisingly favorable course thus far. Papillary lesions are generally regarded as less favorable than follicular carcinomas for radioactive iodine pickup, but such is not always the case. Therefore, use of radioactive iodine is justified even though the prognosis may initially appear poor.

In some cases, tracheal or esophageal involvement may occur late in the course of treatment of thyroid carcinoma, and may take a bizarre form, yet may be attended by a relatively favorable prognosis. This is exemplified in the following case, which actually provided the initial stimulus for this study.

CASE 6. W.J.R., a 75 year old white male, was admitted to the Roper Hospital June 8, 1955, having been referred from another city. He gave a history of having had thyroidectomy for carcinoma nine years previously. After his initial surgery, he had a favorable course until 1953, when he began to have occasional hemoptysis. About one month before admission he developed dyspnea and was seen by his referring physician, who performed a tracheostomy and biopsied a mass in the trachea 3 cm below the level of the vocal cords, and attached to the wall of the trachea. He received conflicting pathology reports from two sources; the patient was therefore referred for further study. Tracheoscopy and biopsy of the tumor were done on June 10, 1955. The Medical College Pathology Department reported this to be thyroid carcinoma invading the trachea (Fig. 11). It was described as producing occasional follicles containing colloid. X-rays of the chest and esophagus on June 10, 1955, were essentially negative.

Radioactive iodine tracer studies showed essentially normal pickup in the neck and 24 per cent retention in the neck at the end of twenty-four hours. The patient was given 65 millicuries of I-131 on June 21, 1955.

He failed to return for follow-up and was not seen again at the Medical College Cancer Clinic until April 26, 1956. He related at that time that he had received x-ray therapy under the direction of his referring physician because of continued bleeding shortly after his visit at the Cancer Clinic.

Examination on April 26, 1956, showed persistence of bilateral abductor paralysis. He was still wearing a tracheostomy tube. Tracheoscopy revealed the presence of tumor attached to the left lateral wall of the trachea, perhaps slightly smaller than on the previous examination. Local excision of the tumor, possibly by loop cautery, was recommended, but thus far has not been accepted by the patient.

*Comment.* Hemoptysis was the initial symptom of recurrence of this carcinoma of the thyroid. Grimes and Bell<sup>13</sup> have emphasized "that hemoptysis in association with goiter, especially one which has shown recent growth, should indicate malignancy of the thyroid gland, or a malignancy primary in the larynx or hypopharynx secondarily involving the thyroid gland." In this case, however, when hemoptysis



occurred there were no palpable masses in the neck. Thyroidectomy had been performed over seven years previously, with apparent control of the neoplasm.

Various other methods of surgical therapy for eradication of the only known residual carcinoma might be offered the patient in this case. These include 1) partial excision of the trachea with reconstruction employing a tantalum mesh stent and fascia lata, as described by Cahan,<sup>14</sup> 2) resection of a full segment of trachea, with anastomosis if possible, or insertion of a bridge of polyethylene tube or other material, as described by Pressman,<sup>15</sup> and 3) total laryngectomy and resection of the trachea down to the level of the present tracheostomy. Each of these methods has its limitations and in view of the patient's favorable course thus far, none has been urged.

#### COMMENT AND SUMMARY

The treatment of carcinoma of the thyroid naturally falls into the field of the general surgeon, particularly one interested in neoplastic diseases. The otolaryngologist may, however, be called upon to assist in the diagnosis and care, especially the emergency care, of patients in whom involvement of the food and air passages has occurred. Tracheostomy is the most common emergency requirement and its performance may prove to be extremely difficult. A preoperative roentgenogram for localization of the displaced trachea, the assistance of a competent anesthesiologist, and the availability in the operating room of necessary instruments such as a Mosher life-saver are essential. A biopsy should always be obtained as the histologic picture may determine further therapy.

Involvement of the food and air passages by an undifferentiated carcinoma usually indicates a poor prognosis although temporary palliation may be achieved by relief of obstruction and the use of some form of radiation therapy. In the better-differentiated follicular and papillary carcinomas, even with extensive invasion, the prognosis may be surprisingly good and it is therefore imperative that emergency measures be carried out promptly and effectively, and that more definite forms of treatment in the proper hands be made available to the patient.

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## Society Proceedings

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### CHICAGO LARYNGOLOGICAL AND OTOLOGICAL SOCIETY AND THE CHICAGO PEDIATRIC SOCIETY

*Meeting of Monday, November 4, 1955*

A joint meeting of the Chicago Laryngological and Otolological Society and the Chicago Pediatric Society, Dr. Maxwell P. Borovski, in the Chair.

#### **The Present Status of Otitis Media**

PHILIP ROSENBLUM, M.D.

AND

JOHN R. LINDSAY, M.D.

CHICAGO, ILL.

(Abstract)

DR. PHILIP ROSENBLUM: Since the advent of sulfonamides and antibiotics, complications such as meningitis, thrombosis of dural sinuses, abscess of the brain and mastoiditis are rarely seen, but not entirely eliminated. The factors involved are many, such as delayed, insufficient and improper treatment. Myringotomy is still necessary in many cases and would facilitate healing with minimum damage to the middle ear. This also permits cultures and sensitivity tests to be made.

More liaison between pediatrician and otologist is desirable and necessary for proper treatment, and to avoid serious hearing difficulties in future life.

DR. JOHN R. LINDSAY: The types of otitis media with which the otologist has to deal in childhood years may be roughly divided into three: 1) acute inflammatory processes involving the tube of the middle ear in suppuration; 2) chronic inflammatory processes;

3) chronic middle ear suppuration. The first two groups are of equal interest to the pediatrician and the otologist. The acute inflammatory processes are more often treated by the pediatrician, the otologist being called in only in the event of failure to cure the suppuration or a persistence of a hearing defect.

Antibiotic therapy has removed most of the element of danger to life from acute middle ear suppuration; surgery is necessary only in rare cases. Two points in the treatment of acute middle ear inflammation about which there has been some divergence of opinion at times have been, first, when, in the course of the disease, to start antibiotics and, secondly, whether or not to incise the drum. My own view is that whenever there is definite evidence of extension of the inflammatory process of the middle ear it is best to start antibiotic therapy at once without waiting for the results of a culture. In this way the extension of infection into the cell system is most easily prevented. Although many acutely inflamed ears may be due to a virus and therefore not require antibiotic therapy, it is preferable to assume at the onset in most cases that the infection is bacterial. Incision of the drum is not essential in most cases to get the infection to subside. However, the cell system which is the seat of suppuration can be likened to a closed abscess. In the presence of a bulging drum drainage is clearly indicated. Drainage of an abscess in such places as the brain or a thrombosed sinus, for example, is necessary to obtain a cure, even with antibiotics.

The greatest concern of the otologist at the present time is with the preservation of function in the inflamed ear. There has been an increase in the incidence of retained exudate in the middle ear following acute inflammations. This occurs following both virus and bacterial infections. Otologists have been concerned that the increased incidence may have been contributed to by antibiotic therapy without drainage of the middle ear. It is not certain whether failure to incise the drum during the acute stage of suppuration contributes to the retention of exudate afterward. However, otologists are of the opinion that when there are signs of pus in the middle ear the drum should be incised.

In my experience in recent years the majority of children who seek the otologists's advice are those who do so because of impaired hearing. In most of these the loss of hearing is due to retention of either a thick exudate or a transparent serous fluid in the middle ear space with complete exclusion of air. This condition is commonly called secretory or serous otitis media. It may be the first evidence of advancing tubal obstruction. If not relieved there is a tendency to develop middle ear inflammatory changes with each successive

infection. Eventually the process is no longer reversible and the hearing impairment is permanent. The earlier that tubal blockage and secretory otitis media can be recognized the greater is the likelihood of preventing damage to the ear. The greatest difficulty with secretory otitis media in children is the diagnosis. The ear drum in the case which has a middle ear filled with fluid in place of air may be mistaken for normal. The contour of the drum is likely to be normal in the early case and the landmarks are present. The best clue to the middle ear content is the increased tendency to transparency of the drum and the narrow chalky appearance of the handle of the malleus. In children over six years of age a careful hearing test will detect or confirm the presence of pathology. Under six years of age the diagnosis will depend upon the otoscopic examination or, if both ears are affected, the observation of the parents that the child does not hear well or pay attention. In children the great majority of cases of secretory otitis media are due to hypertrophied adenoid tissue plus infection. Hypertrophy alone does not usually cause an ear complication. It is during the acute inflammatory episode that damage occurs.

The question of treatment of tonsils and adenoids will be discussed by Dr. Galloway. In my experience the most common indication for attention to the adenoids and tonsils in children is the presence of chronic nonsuppurative otitis media and tubal obstruction. The treatment which is usually effective in these children is a careful adenoidectomy and, if over four years of age, a tonsillectomy as well. Radiation is reserved for cases in which a careful adenoidectomy with the appropriate local treatment to the ears has failed to produce a good result. It is only on rare occasions that we now find a definite indication for the use of radiation.

#### DISCUSSION

DR. FRANCIS LEDERER: I think my particular province here is to represent antiquity. It has been said that it is a sign of senility to reminisce. One of the earliest and most traumatic experiences I had was to appear before the Chicago Pediatric Society in the late 20's, when the late Dr. Joseph Brennemann gave a paper on otitis media in children and said that in all his experience he had never seen a case of surgical mastoiditis. In reply, I remember saying at one time that I had never had a case of lung abscess following tonsillectomy, and some internist said, "Maybe that is because you do not see your lung abscesses—we see them." Dr. Brennemann replied that when I had as many gray hairs as he had I would think differently!

At a meeting of this Society in 1931, the fathers of three of our present members, Drs. Pollock, Holinger and Andrews, presented

papers, and I discussed Dr. Andrews' paper on acute mastoiditis. Has the problem changed that much in these 24 years? Are we having what we anticipated in many other types of disease, a change in the bacterial flora? Did we talk about myringotomy, and are we now talking about it? Are we discussing the same problem? Were serous otitis and otitis simplex (the so-called pediatric ear) not recognized years ago? I think so. We had mastoid surgeons then who resorted to surgery when an otitis was about three to seven days old! There were those of us then who were more inclined to take a more conservative attitude and allow medical treatment to supersede surgical intervention.

What Dr. Rosenblum and Dr. Lindsay have said represents in no way a difference of opinion. There is no difference of opinion for anyone who knows the ear anatomically and clinically, and there should be no difference of opinion between pediatricians and otologists if they are talking the same otologic language. To give up inspection of the ear for the sake of antibiotics is no way to practice medicine. In the Chicago School Survey, 69 per cent of the parents were not aware that the children had problems related to the ear. Is not this a confession of failure? Many of these were ears that were given the antibiotic crutch to escape surgical indications, only to jeopardize hearing.

You heard Dr. Rosenblum allude to cholesteatoma and otogenic complications. These still exist to endanger the lives of ear patients. I would remind you of the work of Drs. Tamari and Szanto, who called attention to the fact that antibiotics brought on a new type of pathology. Just as in the lung, there are fibrotic changes in the middle ear and mastoid as well. These frequently are simmering infections. Let us understand that we must treat a focus of fluid or pus in the middle ear or in the mastoid and alleviate the immediate condition by evacuating the fluid, thereby preventing hearing loss and life-endangering complications. I should like to go along with Dr. Rosenblum: adenoidectomy is more often indicated than performed. The technique is admittedly poor. As one of our residents said: "Adenoidectomy and tonsillectomy are the easiest operations to perform poorly." However, when properly indicated and performed they have a merited place in our armamentarium.

DR. PHILIP ROSENBLUM (closing): I agree with both Dr. Lederer and Dr. Lindsay, but I do feel that early diagnosis is necessary. I think the point to stress is early diagnosis and thorough treatment. The chronic case is often the result of not carrying through properly. Otitis media, handled early and adequately, will not get to the otologist very often.

DR. JOHN R. LINDSAY (closing): I would like to make one further comment. If we follow the principle of making certain after every case of acute otitis media that function has returned to normal, this would be a most important contribution to the welfare of the child's hearing.

### **Irradiation or Surgery of Tonsils**

THOMAS C. GALLOWAY, M.D.

AND

ERICH UHLMANN, M.D.

CHICAGO, ILL.

(Abstract)

DR. THOMAS C. GALLOWAY: Irradiation of diseased tonsils and adenoids, popular thirty years ago, later fell into disrepute. Results disappointed the men who followed these patients, and exploitation and poor techniques cast doubt on the technique. Later reports such as those of Uhlmann and others indicating better control, better methods and improved results have revived interest.

Meanwhile, indications have become more strict for surgery. At the Evanston Hospital in 1935, 1007 tonsil and adenoid operations were performed. In 1953, only 470 were done although the hospital was 50 per cent larger. Also, control by sulfonamides and antibiotics of acute infections and secondary effects seemed to lessen the need of removal. Greater recognition of allergy and better control of nutrition were important factors.

Apparently acute otitis media and mastoiditis have been controlled by newer agents, but otologists have noted a disturbing increase of hearing impairment, due to serous and adhesive otitis, responding poorly to treatment and probably due to uncorrected obstruction and recurring infections.

The importance of focal infection has again been emphasized by Rhoads, Coleman and Kolmer. It does not seem possible to control foci permanently by newer agents or by irradiation.

A possible susceptibility to poliomyelitis any time after tonsillectomy is feared by a number of authors. The writer, after long and intensive study of the many contradictory statistics, has agreed



that if poliomyelitis does occur within two months of tonsillectomy, the dangerous bulbar form is much more likely to result. I have not been convinced that there is, later, any actual increase of susceptibility. Fallacies of poor reporting, study of hospital rather than general populations, and personal bias enter greatly into conclusions. No good explanation is offered for such action in accord with present views of the pathogenesis of poliomyelitis. An equally valid conclusion, if one grants the calculations of Anderson and others, would be that these patients were predisposed to poliomyelitis by the same susceptibility to infection that made them candidates for tonsillectomy. Seydell, in 1916, found tonsils present in 200 of 203 patients with polio, and was equally justified in feeling that tonsils actually provided an atrium for the virus.

Surgery has failed at times, but in proper hands the complications are minor compared to the great benefits. For example, Works reported in 28,000 cases no deaths, only 63 postoperative hemorrhages and 28 other mild complications. Recurrences do occur after surgery.

Reports by Clark and others raise grave doubts about the use of irradiation electively. All of Clark's 13 cases of carcinoma in children had received irradiation from four to fifteen years earlier for disturbance of thymus, cervical glands, tonsils and adenoids, or chest. Duffy and others found similar relationship. Since the carcinogenic action of x-ray may not be manifest for from 4 to 20 years or more, this evidence cannot be taken lightly.

Irradiation may be an ambulant treatment, is less likely to provoke acute flare-up of infection, and may be used with patients with allergy or in poor general condition and may be effective against scattered follicles.

Surgery of tonsils done under proper indications has in my experience given much more certain and lasting results and relief of symptoms and secondary effects. In proper hands, at the right time, with the protection if necessary of sulfonamides and antibiotics, the danger is almost negligible.

DR. ERICH M. UHLMANN: I would gladly take up Dr. Gallo-way's challenge to discuss the biological effects of radiation, which I consider a most interesting subject. However, I prefer to limit myself to the more practical problem—the question of relating radiation therapy of tonsils to cancer of the thyroid gland. There is no proof that such a connection exists. Of the more than 2500 patients treated in my department for hypertrophic lymphoid tissue in the pharynx during the last 18 years, one single patient later developed carcinoma of the thyroid. This patient was operated on by Dr.



Clark. Furthermore, of 11 patients treated in my department for carcinoma of the thyroid in the age group of 4 to 12 years, not a single one had previously received radiation therapy to the neck area. Of all patients treated in my department for carcinoma of the thyroid, the total number who had previous irradiation in one form or another is three.

I believe it would be wrong to get panicky about the observations published by Dr. Clark, and to draw drastic conclusions. I am not convinced that there is any proof of a direct connection between the radiation therapy and cancer of the thyroid in the published series. There are many possible explanations of which I shall quote only a few:

- 1) I consider it possible that the same reason which is responsible for the enlargement of the thymus of some of the cited patients could also be responsible for the enlargement and eventual development of malignancy of the thyroid.

- 2) The ratio of carcinoma of the thyroid between the two sexes is approximately ten females to one male. Since radiation therapy for tonsils is, in our experience, given to both sexes in an equal proportion, this should effect the proportion of the occurrence of thyroid cancer with regard to the two sexes. However, Dr. Clark's paper indicates that there were 12 girls and one boy in his group.

- 3) Cancer of the thyroid may have been present when these children were first exposed to irradiation. In one instance in our own experience, a child was referred to us after having failed to respond to radiation therapy for enlarged neck lymph nodes. A biopsy was suggested and performed and revealed carcinoma in so-called aberrant thyroid tissue. We were dealing with a metastatic carcinoma of the thyroid which, on clinical examination, had been erroneously considered to be lymphoid hyperplasia and treated as such.

- 4) To my knowledge, x-rays have never produced carcinoma of the thyroid in animal experiments. The only instance of experimentally produced thyroid cancer following irradiation was found with a combination of thiouracil and radioactive iodine. It seems of interest to me that the same author who is so concerned about the effects of small amounts of x-rays to the neck area has no hesitancy in advocating the use of radioactive iodine in many hundreds of patients with thyrotoxicosis.

There are other problems which should be considered and evaluated before any definite conclusions are drawn or statements are made which might induce us to give up a form of therapy which has proven its value.

## DISCUSSION

DR. GEORGE S. LIVINGSTON: The two excellent papers we have just heard are actually not in conflict. All who have had experience with tonsillectomy and adenoidectomy know that with proper indications and technique the results are excellent. The same applies to radiotherapy. The two modes of treatment have been combined in many instances and achieved better results than either alone.

The reports of thyroid cancer following neck and chest irradiation are very disturbing. Certainly the statistics cited do not prove an etiologic relationship, but they should alert us to a potential source of danger and warn us to proceed with great caution. The problem will probably be analogous to the alleged tonsillectomy-poliomyelitis relationship, which is still a statistical football, kicked in all directions according to the convictions of various proponents. We have seen how in this unresolved situation it has been a matter of wise public policy on the part of the medical profession to heed the warnings that have been sounded, by avoiding tonsil and adenoid surgery during epidemic periods. A similar attitude probably will have to be assumed with regard to irradiation until such time as definitive knowledge may have been attained.

Since 1945 the whole world has become exceedingly radiation conscious. Much has been learned of the benefits as well as the dangers, and much more remains to be learned. It seems to me that in the present relatively meager state of our knowledge it would be a wise precaution to at least know how much irradiation every person has received. Perhaps we may be able to establish a universal system of registration, such that each individual will carry an identity card bearing with his blood type and immunization record a listing of dates and doses of all radiation exposures.

DR. ETHEL DAVIS: It is gratifying to hear Dr. Galloway say that one of the contraindications to surgical removal of tonsils and adenoids is the allergic state. Otolaryngology has really come a long way. I should like to amplify the statement that the allergic state may be a contraindication to the removal of tonsils and adenoids: 1) There is something about destructive surgery, that is, removal of tissue from the nose and throat, which may precipitate the manifestations of a major allergy in children with an allergic background who have not previously had such manifestations. 2) These allergic children are particularly subject to hypertrophy of lymphoid tissue. This hypertrophy of tonsils and adenoids produces mechanical obstruction which may be successfully reduced by judicious irradiation. Dr. Uhlmann's experience is impressive. 3) This hypertrophy of lym-

phoid tissue and swelling of the nasal mucosa predisposes to frequent infections of the ears, nose and throat. Measures directed solely against the infection usually prove ineffective unless the underlying allergic reaction is first brought under control.

DR. M. P. BOROVSKY: The indications for surgical removal of tonsils and adenoids versus x-ray therapy is a controversial subject. I was pleased to hear that Dr. Galloway was in favor of x-ray therapy at times and that Dr. Uhlmann sees the need for surgical removal of tonsils and adenoids in certain cases.

The pediatrician seems to be in a better position to judge the indications in a given case for either type of therapy. He sees these children through oft-repeated nose and throat infections with varying degrees of ear, gland and chest complications. These may recur throughout the respiratory infection season and some begin this train of symptoms soon after birth. The clinical observation through these episodes is obviously of greater import than the single examination during a quiescent period when seen by a nose and throat man.

Every case is individual. I had tonsils and adenoids surgically removed from an 11 months old boy who had had enlarged, infected tonsils and persistent posterior nasal obstruction from the age of two months. The improvement was remarkable, and although he comes from an allergic family he now at the age of six has had no major allergic manifestations. The counterpart of this is a girl who had large bulbous tonsils in very early childhood, never had tonsillitis, and is now attending college with her tonsils in situ.

I should be more inclined to condemn x-ray treatment to the thymus gland, which was once very much in vogue, for possible damage to the thyroid gland than I would x-ray exposure of the tonsils and adenoid area to these rays.

Our justifiable concern about poliomyelitis and its association with tonsillectomy may soon be greatly relieved with the advent of mass immunization with the Salk vaccine.

DR. JACK ALLAN WEISS: Considerable information has been presented by the essayists regarding the relative merits of and indications for surgical or irradiation management of the symptom-producing tonsils and adenoids. Much of this data is not wholly contradictory. In fact, it is all relevant and should be applied in order to evaluate each patient as an individual problem.

I should like to mention two points which may be considered objective criteria bearing on the choice between surgery and irradiation. First, it is generally accepted that any clinical improvement

following irradiation is due to the decrease in size of the enlarged lymphoid structures, with lessening of the obstructive factor. Since irradiation does not accomplish sterilization of the bacterial flora of the tonsils, there can be little or no reduction in the infectiousness of irradiated tonsils. That size is no indication of bacterial content has been demonstrated by the work of Rhoads and Dick. Their studies showed that there was a higher bacterial count per gram of tissue in tonsil stumps than in full-sized tonsils.

Secondly, may I quote from a study of my own (to be published later) concerning histologic changes in tonsils following irradiation. This clinical investigation was done with the consent of the parents of the children, and their full knowledge of the purpose and method. In the study of several patients, one tonsil was removed. The other tonsil and the adenoids were irradiated by the standard technique and subsequently removed about one year later. Microscopic examination showed minimal differences between the irradiated and non-irradiated tonsils.

DR. THOMAS C. GALLOWAY (closing): We seem to be in essential agreement. I think you will agree with me after hearing Dr. Uhlmann that irradiation is in excellent hands.

The question of carcinoma is important and it will be interesting to hear from men who make further controlled studies on that. It is true that the roentgenologist can control irradiation so that the thymus is not exposed, but the effect on less sensitive tissues such as the mucosa in the nasopharynx, about which we have had some suspicion, should also be considered. I wrote one of the early papers on treatment of infection with irradiation and found it valuable in presulfonamide days. We are now somewhat worried about its later effect since the latent period of carcinogenic action may be from four to twenty-five years.

We have seen many tonsils taken out and examined microscopically that showed little evidence of morphologic change. We seem to agree on allergy, and usually only after we have sent the patient to the allergist do we remove tonsils. Tonsil infection may be important in triggering allergy.

Dr. Borovsky is right that the pediatrician has the final say. I have almost never taken out tonsils in children without pediatric consultation and I am not willing to do so if overruled by the pediatrician. Occasionally he has seen repeated infections which I have not had the opportunity to see and advises operation when I have not been sure.

**The Team Approach to Speech and Hearing Disorders**

ROBERT HENNER, M.D.

F. J. POLLOCK, M.D.

P. A. CAMPANELLI, M.A.

M. W. JUDIESCH, M.A.

AND

DORIS P. WHEELER

CHICAGO, ILL.

(Abstract)

This presentation describes work being done at Michael Reese Hospital Hearing and Speech Clinic. Various phases of the program are presented by the otologist, the clinical audiologist and speech pathologist, the clinical social worker and the clinical psychiatrist. The Clinic was established about three years ago. It was felt that because of the special activities in the area of brain injured children as well as emotionally disturbed children, such a Clinic would be particularly useful; in addition, specialists in a general hospital could better cope with the problems of hearing and speech handicaps when welded into a group effort.

The plan of operation is outlined: 1) otologic survey; 2) audiological and speech; 3) social service; and special phases of psychometrics, psychiatry, neurology, orthopedics, eye and other problems.

## DISCUSSION

DR. HELMER MYKLEBUST: Many aspects of this problem might be discussed, but that is not possible because of the lack of time. May I comment to the effect that the problem represented by a speech and hearing center is complex. This is because it deals with the problem of speaking, and speaking is a characteristic which is unique, basic and fundamental to human beings. Man is the only form of life which has this capacity, and it is really strange that we do not have more fundamental knowledge with regard to the total problem of speech disorders. I use speech to include hearing, because without hearing there is no speech normally. If I could urge one thing specifically, it would be the importance of team work, because we are dealing with a complex problem from a multiphasic point of view.

When we have such complex problems as difficulty in communicating, it does require background and knowledge of a number of different people with different backgrounds. Much has been accomplished, much remains to be accomplished. The team approach needs more development. There are many controversial issues. The people at Michael Reese Hospital are rendering a service to the community and to us in the completeness of the program they are carrying on.

DR. CHARLES LIGHTFOOT: Needless to say I am in wholehearted agreement with the general point of view, the team approach, because that is what has been followed by the Speech and Hearing Center at the Illinois Eye and Ear Infirmary for some seven years. I would like to make an additional comment. One goal that was set forth in the paper of Dr. Pollock is an organized research program. I think it is most commendable to apply the team approach to research on speech and hearing.

DR. FRANCIS LEDERER: We stated some years ago, from our experience in military service, that Chicago and its environs could stand for eight of these audiological centers. I think it is commendable that in each one, in each hospital facility available to this area, progress is being made. No one person can go it alone in the solution of this problem. The time did not permit the group to tell you the details of the service to be rendered under this program. It seems to me that at this time the teams of medical and perimedical workers have joined forces. Their combined efforts will result in a victorious solution to the problem of communicative disorders. All who are engaged in such work, under the stimulus of otologists, are to be commended for the splendid work that is being carried out.

DR. ROBERT HENNER (closing): With regard to research, the work in progress is on premature children, and we are surveying for hearing handicaps. Briefly, as an otologist with little background in this field, I want to say it has been a rich experience for me. The difficulty of diagnosis and the special education required by these children takes real saints to achieve a maximum result.

## Abstracts of Current Articles

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### EAR

Iontophoresis of the Inner Ear and Adjacent Areas, with the Intratympanic Injection of Drugs. Its Role in the Etiopathogenesis, Diagnosis and Therapy of Diseases of the Ear. I. Its Application in Dropsy of the Labyrinth and in Functional Vascular Processes of the Inner Ear.

*Rius, M.: An. oto-rino-laringol., Uruguay, 25 (Part 2):49-77, 1955.*

Conditions unfavorable for iontophoresis and electroendosmosis of the external auditory passage are the absence of soft connective tissue, interstitial fluid and the presence of an intact ear drum. The main advantages of iontophoresis are 1) that it increases the concentration of the substance used in the localized area and 2) that the electrically introduced medicament remains in the labyrinthine fluid for a period of about seven days, whereas when it is given by the oral or parenteral route it is eliminated in the urine within 24 to 48 hours.

In view of the barrier to iontophoresis associated with the variations in polarization within the inner ear, it appeared advisable to fill the chamber with ionizable fluid. Trowbridge's method has been successfully used for intratympanic injections in the treatment of tinnitus. The middle ear and the promontory are readily permeable by the ions if fluid is present in the external auditory passage and in the tympanic chamber.

To correct local circulatory insufficiency in auditory disease due to hypertension or to anoxia, Prisol® was used to produce vasodilatation of the arteries and arterioles. This drug improves the nutrition of the organ of Corti and of the entire inner ear by relieving the biochemical and enzymatic conditions responsible for the local symptoms. Hyaluronidase was also employed to facilitate the diffusion of Prisol through the inner ear and thus to improve the circulation and overcome the local hydrops.

As local anesthetic Rius injected aniline oil 90 parts and cocaine hydrochloride U.S.P. 10 parts. This was followed by the intratympanic injection of 0.1 cc of Prisol and 0.1 cc of hyaluronidase solution in distilled water. A glass tube was introduced within which was a long fine wick of cotton moistened with 10 per cent solution of Prisol in double-distilled water. The positive pole was connected to the wick and the negative pole below the opposite ear which was



well protected with damp cotton. The initial iontophoresis dose was 1 milliamperes continued for ten minutes. This was progressively increased to 15 milliamperes continued for thirty minutes. A week later the audiogram revealed excellent results, there was subjective improvement in hearing and the tinnitus had ceased.

In the first few cases in which this treatment was employed no improvement was obtained but after the technique was perfected excellent results were noted in fourteen cases. Three of these patients suffered from typical Ménière's disease, seven from dropsy with or without initial vertigo and four from Ménière's disease without loss of hearing. The hearing loss was improved in eight out of nine cases, the tinnitus in 11 out of 13 cases, the vertigo in six out of seven cases in which these symptoms occurred.

Ménière's disease is due to general conditions such as arteriolar spasm, ischemia, capillary vasodilatation due to allergies, menopause, stress, lack of tonus, hypertension, hypotension, anemia, toxic conditions, metabolic and endocrine disturbances, hypoproteinemia and avitaminosis. The success of iontophoresis with Priscol supports the local origin of the symptoms.

The hydrops appears to be due to changes in hydrostatic pressure in the arterioles. Priscol dilates the arterioles and raises the capillary hydrostatic pressure so that the filtration of fluid into the interstitial spaces is increased.

HIGBEE.

#### Idiopathic Hemotympanum.

Vaquero Garrido, C. G., and Ortega Garcia, A.: *Acta oto-rino-laringol., Ibero-Amer.*, 6:427-439, 1955.

Blue tympanum may be due to two completely different conditions, i.e., to collections of blood in the middle ear or to transparency of a prolapsed jugular vein. Accumulations of blood may result from trauma in which case they disappear within a few weeks or may be idiopathic and without apparent cause. The latter type does not disappear spontaneously. The eardrum may remain blue even after myringotomy and drainage of the hematic fluid. In some cases the impaired hearing improved after operation but the fluid collected again. In two cases improvement followed removal of the tonsils and adenoids. Mastoidectomy and removal of a viscous fluid within the antrum restored hearing in one case in which the blue color did not return. However, in another instance, repeated mastoid hemorrhages



occurred and the blue color of the eardrum reappeared eight months after aspiration of the fluid. Hematoma of the eardrum may result from hemorrhage without inflammation or perforation causing deafness, tinnitus and vertigo resembling Ménière's disease. In one case coryza was followed by deafness and hemotympanum which gradually disappeared spontaneously.

During the operation the mastoid cells were found to be filled with a viscous, rather dense fluid. The extirpated bone fragments were granular, with giant cells and spaces containing cholesterol crystals and hemosiderin granules in the macrophages. The cholesterol may be precipitated from the circulating blood or may possibly be due to degeneration of the epithelium although operation rarely reveals extensive changes. It is most probable that the cholesterol is precipitated from the red blood cells of the degenerated hematic fluid in the cavity.

Aside from trauma, hemorrhagic diathesis may be responsible for the hemorrhages. The most probable etiologic factor is influenzal otitis or nasal catarrh with intense congestion of the blood vessels and inflammation. The deposition of cholesterol crystals bears out this hypothesis.

Prolapse of the jugular vein is of great importance in the differential diagnosis. It can be distinguished from hemotympanum by the location of the blue color in the lower portion of the membrane as compared with its involvement of the entire drum in tympanic hemorrhage. In prolapse of the jugular vein the appearance varies with the position of the head but this is not the case in hemotympanum.

Treatment varies according to the individual conditions. Surgical intervention is rarely indicated. Relieving nasal congestion and insufflation of the tympanum, myringotomy, and drainage of the fluid are usually successful. In cases of otitis media mastoidectomy may be employed to advantage.

HIGBEE.

#### *Iontophoresis of the External Auditory Passage in the Treatment of Dropsy.*

Rius, M., and Visca, A. M.: *An. oto-rino-laringol.*, Uruguay, 25 (Part 2):46-48, 1955.

The patient, a young woman, complained of loss of hearing and tinnitus in the left ear. The condition had begun suddenly, several months previously with an attack of rotatory vertigo lasting for three

days. Catheterization and insufflation of the eustachian tube, short wave applications, and polybromides had not been effective. Chills and sneezing attacks preceded an increase in the degree of deafness. Except for urticarial reactions to chocolate and to fish the patient was otherwise normal. On examination, perceptive deafness and recruitment were noted, caloric tests revealed moderate reduction of reflexes on the left side.

Treatment consisted in reduction of the fluid and salt intake, ammonium chloride, mercurial diuretic medicaments, subcutaneous administration of histamine and vitamins B-12 and B-6. No improvement resulted. Histamine given intravenously drop by drop was somewhat more successful. In view of the peripheral vasodilatation produced by histamine, Priscol® was substituted. Priscol (2-benzyl-4, 5-iminazoline hydrochloride) acts upon the small arteries, and arterioles, while histamine dilates the capillaries. In place of the cyanotic skin color produced by histamine, a clear red coloration is noted in regions treated with Priscol.

To confine the action of the Priscol to the affected region, the drug was given by iontophoresis. There is no record in the literature of a previous use of this method. The effect was tested by audiograms before and after treatment. The initial dose of Priscol was two drops of a 10 per cent solution in 2 cc of distilled water, applied by iontophoresis, beginning with small doses of 0.5 milliamperes for ten minutes at a time. The daily doses were increased up to 1 milliampere continued for 30 minutes. However, no improvement of the tinnitus or deafness resulted. The condition was diagnosed as hydrops of the inner ear.

HIGBEE.

#### New Surgical Techniques in Transmission Deafness.

DeMumbert, A. V.: *Bol. Españ. Otorrinolaringol. y Broncoesofagol.* 8:2:13-19, 1955.

Two new surgical procedures are described: 1) mobilization of the stapes (Rosen) and 2) plastic repair of the ear drum (Wulfstein); both have contributed greatly to the treatment of transmission deafness.

Mobilization of the stapes is indicated in cases of rheumatic or senile ankylosis, otosclerosis, tympanosclerosis, or otitis with adhesions. The method to be used depends upon the clinical history of local or general infections, especially otorrhea, the condition of the tympanic membrane, as determined by otoscopy, tonal and vocal audiometric

findings as to the type of deafness, whether purely one of transmission or associated with atrophy of the cochlea, the degree of mobility of the ear drum, the condition of the posterior labyrinth and psychoneurologic findings.

The operation is carried out under local anesthesia with 2 per cent novocain and adrenalin 1:1000. A curved incision is made and the skin is laid back to expose the tympanic chamber, the articulation of the incus and stapes and the branches above the promontory of Jacobson's plexus. Hemostasis is maintained by electrocoagulation of the small blood vessels. The stapes is freed and mobilized, if firmly adherent, by means of traction with a special Rosen spatula. As soon as the adhesions are freed the patient experiences an immediate improvement in hearing, as in the case of fenestration of the labyrinth. The area is freed from any other possible cicatricial adhesions or fibrous sequelae of old inflammatory processes of the middle ear. The tympanic membrane is replaced and a soft tampon of fibrin sponge is inserted to fill the entire chamber. This is renewed every three days and is finally replaced by sterile gauze. No antiseptic is used, but massive doses of antibiotics are given for three days before and for one week after the operation. If hearing is restored in that ear the operation is repeated on the contralateral ear if the deafness is bilateral, which is usually the case, except in otitis which adhesions.

The only reasons for possible lack of success are incomplete liberation of the stapes, suppuration, secondary fibrosis, ankylosis of the ossicles, or atrophy of the sensory epithelium of the cochlea. Operative accidents are rare. The simplicity and the safety of the method are advantages. This intervention is also indicated in cases of tinnitus on a vascular basis, associated with transmission deafness and slight atrophy of the cochlea. It reduces the hypertension of the perilymphatic fluid and therefore the exciting stimulus causing the auditory sounds. In such cases, section of Jacobson's nerve plexus is sometimes advisable. The technique may well be employed in place of the fenestration methods now in use to relieve tinnitus.

Plastic repair of a centrally located perforation of the tympanic membrane (Wulfstein) consists in the insertion of a free dermoepidermal graft, which closes the gap and heals in two or three weeks. Provided the chain of ossicles is mobile, hearing is improved by 25 db in all frequencies by this repair. In the case of a large marginal perforation, a skin graft is inserted by means of a retroauricular incision.

In case of chronic otorrhea, a partial curettment is carried out, the lesions in the attic of the middle ear are treated, and later, when

the discharge has ceased completely, a large graft is inserted, on a bed of absorbable gelatin or a fibrin sponge. This results in considerable gain in auditory function.

HIGBEE.

**The Vegetative Nervous System in Audiology.**

Vials, R. P.: *Acta Oto-rino-laringol. Ibero-Amer.* 6:5:331-360, 1955.

Lermoyez's syndrome, resulting in sudden deafness, vertigo and tinnitus, is due to angiospastic phenomena based upon vestibular hyperreactivity. Barcé-Lieou's vertigo is a manifestation of changes in the sympathetic nervous system. Other similar conditions resembling Ménière's disease are also due to angiospastic involvement of the labyrinth. This is demonstrated by the results of cervical sympathectomy in the treatment of Ménière's vertigo, tinnitus and headache following otitis. The injection of ethyl morphine into the tympanic cavity relieves conduction deafness with tinnitus. Section of the stellate and superior cervical ganglia inhibit Ménière's vertigo. Stellectomy is somewhat more effective in the treatment of deafness and tinnitus. According to Rosen, stimulation of the chorda tympani results in vertigo and tinnitus and section of this nerve is accompanied by the sensation of a loud sound. This would suggest the existence of an inner relationship between VII, VIII, IX and X cranial nerves. Patients with dental malocclusions sometimes suffer from earache, tinnitus and vertigo and deafness, possibly due to compression of the chorda tympani near the temporomaxillary articulation.

Experiments with cats using electric stimulation of the cochlea demonstrated the presence of a reflex arc from the stimulated ear over the central nervous system to the contralateral ear. Histologic changes in these cases consisted of alterations of the endolymphatic fluid, concavity of Reisner's membrane due to pressure exerted by the fluid, and exudation due to changes in the walls of the stria vascularis.

The parasympathetic innervation of the ear includes the tympanic plexus, especially Jacobson's nerve, the branch of the glossopharyngeal nerve which penetrates the floor of the chamber, ascends to the promontory and anastomoses with the inferior superficial petrosal nerve. The sympathetic nerves run by way of the caroticotympanic branch, across the small orifices of the anterior surface of the chamber, dividing into the superior and the inferior caroticotympanic nerves. This plexus has many small ramifications which innervate the oval and the round foramen and the roof of the eustachian

tube. They unite with the carotid branch and with the superficial inferior petrosal nerve, extending to the otic ganglion and forming the vasomotor and secretory innervation of the parotid gland. From the carotid-sympathetic plexus branches extend the sphenopalatine ganglion, stimulating the secretory and vasomotor functions of the lacrimal gland and of the nasal mucosa.

To determine the possible existence of an efferent cochlear innervation and its relation to the vegetative nervous system, Viñals injected novocain (2 mg/kg body weight) intravenously. Audiograms were made before and after the injection to determine the influence of the vegetative nervous system upon functional tests of hearing. In some cases the injections were repeated daily for seven days during which the dose of novocain was reduced to 1 mg/kg weight.

The marked hypotensor effect of the novocain, which is a sympatholytic agent, upon the cochlear blood vessels indicates the importance of the vegetative nervous system in the auditory function and consequently its value in diagnosis and the effectiveness of sympathectomy and parasympathectomy in the treatment of auditory disturbances.

HIGBEE.

#### Modification of the Individual Thresholds in Recruitment.

Leon, G. De S., and Sarraile, E. C.: *Acta Oto-Rino-Laringol. Ibero-Amer.* 6:4:297-305, 1955.

Recruitment occurs in cases of deafness due to lesion of the organ of Corti. The authors suggest a test based upon changes in the range or thresholds for perception of loudness expressed by graphic curves. The curve of minimum audibility is first determined, then the curve for comfortable loudness is established. Frequencies of 1,000, 3,000, 500, 2,000, and 4,000 are tested in that order and are repeated and modified until the optimal level is obtained. The curve for the threshold of auditory discomfort is determined in the same manner. Intensities causing actual auditory pain are avoided. All three curves are recorded on the same audiogram. The authors use different colors for the curves for the right and left ear and dotted and solid lines, respectively, to denote comfortable and disagreeable intensities.

In the graphs for normal hearing the four curves run parallel at intervals of approximately 40 decibels intensity. In conduction deafness the relative distances between the curves are still equal. If the degree of deafness is severe, the curve for disagreeable tones may be

absent. No recruitment occurs in these cases. In mixed deafness, also, in the absence of recruitment, the curve for disagreeable intensities may be absent. The curve for comfortable loudness is closer to the curve for normal auditory perception. In lesions of Corti's organ, the curves are only a few decibels apart and almost coincide. Recruitment may be noted on all the curves or only at certain frequencies. Thus the test is selective and diagnostic.

In perception deafness on a neural basis, due to lesions at a distance from Corti's organ, beyond the first neurone, no recruitment occurs, and the curve for disagreeable intensities may be absent. Recruitment may be assumed to exist if the curves for comfortable and for disagreeable intensities are less than 40 decibels apart. Extreme recruitment is revealed by intervals of less than 20 decibels between the curves.

This method of diagnosis has the advantages of simplicity, rapidity, facility and accuracy. The only disadvantage lies in errors due to individual differences in sensitivity, intelligence, and musical perception.

HIGBEE.

## NOSE

### The Treatment of Vasomotor Rhinitis by the Injection of Calcium into the Turbinates.

Verdaguer, J.: *Bol. Españ. Otorrinolaringol. y Broncoesofagol.* 8:2:21-23, 1955.

Vasomotor or allergic rhinitis, also called spasmodic coryza, is a local nasal manifestation of a generalized condition. Treatment of the local symptoms fails to remove the underlying cause.

The outstanding symptoms are primarily obstruction and nasal secretion but headache, attacks of sneezing, and respiratory difficulty may be present. Chemical cauterization, or electrocoagulation of the turbinates, have the disadvantage that there is danger of causing fibrosis or atrophy of the mucosa.

The author advises the injection of 10 per cent calcium chloride into the turbinates. He uses a metal syringe with a fine needle, and exerts enough pressure to infiltrate the mucosa without danger of rupture. The needle is bent at an angle to ensure visibility. The operative field should be well illuminated. Local anesthesia is employed. Approximately 5 to 7 cc of the calcium chloride are injected. The needle is inserted deeply into the turbinate and is

withdrawn slowly after the injection so that the remaining drops infiltrate the entire area. Hemostasis is maintained by silver nitrate or by electrocoagulation of the small blood vessels. There is no post-operative pain or rhinorrhea. Large doses of the calcium may result in transitory obstruction of the tear ducts, but this symptom disappears within a few days.

HIGBEE.

#### Malignant Tumors of the Pyriform Sinus.

*DeMumbert, A. V.: Bol. Españ. Otorrinolaringol. Broncoesofagol. 8:1:13-21, 1955.*

The author has observed 85 cases of this condition within twelve years, usually in male patients fifty years or more of age. The tumors frequently form on the side on which dental defects have resulted in the swallowing of insufficiently masticated food. By the time they are recognized they are of considerable size, and are frequently ulcerated. The most common type is prickle-cell epithelioma, sometimes keratinized.

During the initial stage the symptoms are: difficulty and pain on swallowing, earache, sialorrhea, cough, a sense of constriction on the side of the neck in the hyoid region and paroxysmal dyspnea. Examination usually reveals involvement of one or more lymph glands, feter oris and accumulations of purulent saliva in the pyriform sinus of the affected side. The otalgia is due to compression of the auricular branch of the vagus nerve during the continual swallowing of saliva.

Later when the symptoms become more acute an ulcerous mass may be demonstrated in the sinus. The arytenoepiglottic fold is edematous. This is a danger signal which indicates an invasion of the subjacent tissues. Another significant symptom is disappearance of the laryngeal crepitation on the affected side. The lymph nodes become increasingly larger as the edema increases, causing compression of the blood vessels. The hyoid bone and the upper portion of the thyroid cartilage may be infiltrated and fused. During the terminal period, disturbances of respiration, deglutition and phonation increase. The patient becomes unable to eat or speak. The otalgia affects both ears and movements of the neck are cause of considerable pain. Cachexia, bronchopneumonia, septicemia and sudden massive hemorrhage result in death.

Indirect or direct laryngoscopy, tomography and contrast roentgenography in anteroposterior projection are useful diagnostic aides



during the initial stages when the symptoms of dysphagia, dysphonia and sialorrhea first appear.

The differential diagnosis must exclude the possibility of syphilitic ulcer, calcification of the lymph nodes, and laryngeal tuberculosis.

During the early stages, surgical treatment is indicated, preferably pharyngectomy or lateral pharyngolaryngectomy, with radical extirpation of the lymph nodes on the affected side to prevent metastases and recurrence. Clinical recovery occurs in 20 per cent of cases but if postoperated radiotherapy is given recovery occurs in 47.8 per cent. Once the condition is advanced surgical removal of the lesion is contraindicated and treatment consist of deep radiotherapy and extirpation of the lymph nodes, tracheotomy, and feeding through a nasoesophageal tube. Palliative treatment such as diathermic coagulation and insertion of radium are of little use.

In the terminal period all radical treatment is useless. One can only safeguard respiration and nourishment by intubation, relieve the acute pain, prevent fatal hemorrhage, maintain fluid balance and the general condition as well as possible. The prognosis is unfavorable unless the condition is recognized in the early stages. According to a 1946 report clinical recovery resulted in 4.6 per cent of cases, temporary cure in 13.8 per cent, slight improvement in 33.9 per cent and death ensued in 47.7 per cent.

HIGBEE.

### LARYNX

#### The Fight Against Cancer of the Larynx. Report of Nine Cases Operated Upon in 1954.

*Andrades, D. J.: Bol. Españ. Otorrinolaringol. Broncoesofagol. 8:1:23-27, 1955.*

Prevention of cancer in general is based upon prophylaxis and early diagnosis. Prophylaxis of laryngeal cancer includes avoidance of smoking, especially of raw tobacco and treatment of precancerous lesions. Tobacco is not the only factor in the genesis and development of the cancer but it is an important cause and accelerates the disease process. Conditions to be carefully watched for are chronic laryngitis due to alcohol, tobacco, syphilis, papilloma and leukoplakia. Early diagnosis is difficult because an incipient cancer may not be readily visible by indirect laryngoscopy and may remain latent for some time without causing dysphonia or dyspnea. One per cent of apparently healthy adults have cancer. In Spain, in 1950, 21,000 persons died of cancer. In 2,051 cases the respiratory tract was involved; in 1,435 of these cases the cancer was situated in the larynx.



It is only during the initial stage that treatment is efficacious in removing the cancer without destroying the function of the larynx. If the lesion is recognized before infiltration of the underlying tissues takes place, roentgenotherapy is successful in practically all cases. Later, however, no cure is possible. The same applies to surgical treatment. Partial resection of the mucosal and cartilaginous tissue is successful in 70 per cent of cases if the lesion is superficial and non-infiltrating but recovery ensues in only 50 per cent if infiltration or extension of the lesion necessitates total laryngectomy.

The author reports on nine cases of vestibular laryngeal epithelioma operated on in 1954. In all cases the symptoms remained latent until the condition was so advanced as to necessitate total laryngectomy. The nine patients were all heavy smokers. Dysphonia was a delayed symptom in five cases, dysphagia in four, bloody sputum in five, invasion of the pre-epiglottic space in seven, invasion of the base of the tongue in two, local recurrence in the anterior cervical region in one fatal case, recurrence in the regional lymph nodes in one case, invasion of the vocal cords in seven cases, precancerous proliferation of the cords in one case. In all nine cases the lesion was the prickle cell differentiated epidermoid epithelioma.

Operation was carried out from ten to three months before this report. The condition of the patients is satisfactory in most cases. The supraglottic area was first involved in all nine instances, with later invasion of the glottis and of the underlying region.

Thanks to the prompt diagnosis, before the vocal cords were involved, partial supraglottic resection could be carried out, leaving the cords intact. In advanced cases conservative surgery is unsuccessful. Recurrence and death are inevitable.

HIGBEE.

## PHARYNX

Sarcoidosis. Besnier-Boeck-Schaumann's Disease. Pharyngolaryngeal Localization as the Primary Clinical Manifestation.

Munoz, J. C., and Malosetti, H.: *An. oto-rino-laringol.*, Uruguay, 25: (Part 2):29-45, 1955.

This condition is a chronic inflammatory process involving the reticulo-endothelial system. The etiology is unknown, although the frequency with which a sarcoid cutaneous lesion develops into lupus vulgaris suggests a tuberculous origin. Other conditions such as

leprosy, foreign bodies, paraffin, beryllium, leishmaniasis, moniliasis and brucellosis produce similar lesions. Unlike some other diseased tissues the sarcoid follicle never undergoes caseous degeneration and as a rule the tuberculin reaction is negative. The disease has also been attributed to a filtrable virus or to bovine or avian types of bacilli and also to an unknown factor which causes a granulomatous sarcoid reaction in an organism affected with tuberculosis.

The sarcoid nodule resembles that of miliary tuberculosis. It is made up of large polygonal epithelioid cells arranged concentrically, resembling pavement cells. It frequently involves a blood-vessel resulting in obliterative endarteritis. Later on star-shaped islands form which are encased in connective tissue fibrils. These undergo hyaline degeneration but not caseation.

Symptoms vary according to the tissue or organ primarily affected. If the lungs are invaded, the hilar and mediastinal lymph-glands are also involved. The process may recede spontaneously or may progress. Cutaneous lesions are present in 30 per cent of cases and hepatic, splenic, gastrointestinal, endocrine and pituitary involvement may occur. The condition may be localized in the nasal fossae, tonsils or larynx, causing difficulty in swallowing, hoarseness and respiration.

In the case reported the pharyngeal mucosa was bluish white, smooth and not ulcerated. There was diffuse bluish white infiltration of the larynx involving the epiglottis, arytenoids and aryepiglottic folds. Biopsy revealed nodular granuloma of the mucosal corium with epithelial cells characteristic of Besnier-Boeck Schaumann's sarcoid.

The disease is chronic and may persist for years with occasional remissions. The prognosis is usually favorable except when there is cardiac, cerebral or intestinal involvement.

Treatment is symptomatic, according to the localization. General treatment consists in arsenic, gold salts, vitamin D, ultraviolet irradiation, radiotherapy and radium. Antileprol and streptomycin have also been employed, but with doubtful success. On the assumption that the sarcoid is a form of lymphogranulomatosis mustard gas and urethane have been tried but cortisone is the only medicament which has been effective. The recommended dose is 100 to 150 mg daily. However, recurrences are frequent when treatment is discontinued.

HIGBEE.

**Three Cases of Pharyngoesophageal Diverticulum.**

De La Torre, M. L.: *Bol. Españ. Otorrinolaringol. y Broncoesofagol.* 8:2:90-97, 1955.

The first patient, a man 34 years of age, had increasing difficulty in swallowing, persistent cough and sense of suffocation in the retro-sternal area when lying down. Roentgenography with a contrast material revealed a well-defined, smooth, regular diverticulum in the esophagus extending from behind the manubrium to the right of the median line. The junction of the esophagus with the diverticulum could be clearly seen. On esophagoscopy it was found that the diverticulum opened into the posterior wall near the pharyngoesophageal isthmus. The mucosa was not ulcerated but hypertrophic and granulated. Numerous varicose formations were present in the esophageal wall below the diverticulum.

Penicillin and streptomycin were administered 48 hours prior to intervention which was carried out under general anesthesia. Local anesthesia of the anterior cervical region was obtained by a paravertebral injection of 1 per cent novocain-adrenalin solution into the fifth, sixth and seventh cervical interspaces. The point of insertion of the diverticulum was found below the cricoid cartilage. The sac was enucleated without difficulty as no adhesions were present. Enough of the pedicle was left to ensure adequate closure. A muscular "corset" was formed of the esophageal musculature and the inferior constrictor muscle of the pharynx. A feeding tube was inserted above the suture and a drainage tube below the wound. The sternocleidomastoid muscle and superficial tissues were then closed. The drainage tube was removed in four days and the sutures in eight days. A massive hemorrhage occurred into the mouth four days later for which transfusion of 300 cc blood was given. Recurrent paralysis of the right side was noted for a period of about one year. Roentgenography 25 days after operation showed the esophagus and larynx to be normal.

In the second case the symptoms were continued difficulty in swallowing, frequent regurgitation and sore throat. A round, smooth, diverticular mass, without folds, was found in the esophagus near the sixth cervical vertebra. Esophagoscopy revealed no abnormality of the mucosa except for a granular area at the distal fundus of the sac. The patient suffered from chronic bronchitis, emphysema and cardiac insufficiency. No operation was performed.

The third patient had suffered from profuse mucus which could not be expectorated, sialorrhea and sore throat for ten years. He was under treatment for asthma and persistent cough. Following the

ingestion of food he noted bubbling sounds. Nausea was present when he tried to sleep on his back.

Anteroposterior and lateral roentgenography revealed a large notched diverticulum at the level of the first rib about the size of a tangerine. The esophageal mucosa was normal. The diverticulum was readily and completely removed and a stomach feeding tube was inserted.

Pharyngoesophageal diverticulum occurs mainly in males, 77 to 79 per cent, and usually in subjects over 50 years of age, 70 per cent. Since the symptomatology is sometimes indefinite, anteroposterior and lateral contrast roentgenography and esophagoscopy are essential in clarifying the diagnosis. Preoperative and postoperative administration of antibiotics is advisable.

HIGBEE.

## TRACHEA

### Primary Malignant Tumors of the Trachea.

Iglesias, E. A. P.: *Acta Oto-rino-laringol. Ibero-Amer.* 6:5:381-395, 1955.

The initial symptom in the case cited was dysphonia, which was followed a month later by dyspnea and suffocation. Initial examination revealed a polypoid tracheal growth which almost completely obstructed the lumen. The insertion of a cannula resulted in profuse hemorrhage. The tumor was situated between the second and seventh tracheal rings in the lateral and posterior walls. There were no metastases. Biopsy revealed a vegetative malphigian epithelioma.

A tracheotomy cannula was left in place. As the patient refused radical treatment, roentgenotherapy was carried out: 1500 r applied to the anterior section, 3000 r to the right and left wall, in fractional doses. A tracheolaryngeal fissure was made which revealed extensive retraction of the tissues. The tracheal passage was markedly contracted but the tumor had disappeared completely three months after its first appearance and did not recur. The contraction was permanent and the cannula was left in place.

These tracheal tumors generally affect males. They may also involve the upper digestive passages, the larynx, bronchi, pharynx and esophagus. Etiologic factors include tobacco, inhalation of industrial chemicals, possibly hormonal stimuli. The upper and lower extremities of the trachea are always involved. The posterior wall is the principal site of the tumor, possibly due to the fact that numerous lymph glands and blood vessels are present in this area. There is

little tendency to spread, and the anterior wall is usually intact as are also the tracheal rings. However, the tumor may involve adjacent organs and result in paralysis of the recurrent, phrenic, sympathetic, pneumogastric nerves and the brachial plexus, resulting in pain. The esophagus is frequently affected.

Dysphagia is a diagnostic sign of cancer of the trachea, whereas cough and expectoration are early symptoms of cancer of the esophagus. Dysphonia occurs in both types. The larynx is rarely attacked, due to its histologic characteristics. Metastases to distant areas are rare probably because the lymph glands of the neck have no connection with those of the mediastinum. The infiltrating type of tumor is common and usually results in retraction and narrowing of the lumen. Malphigian epitheliomas are the most frequent type and may be keratinizing prickle-cell or basal cell forms, cylindromas or glandular tumors. The adenocarcinomas may have a dense stroma and may resemble tumors of the mammary gland. Medullary carcinomas and "oat-cell" epitheliomas are rare. The malphigian epitheliomas are always malignant but are limited in extent and may respond to treatment.

In addition to cough and expectoration, vocal changes, dysphagia, pain, asthenia and hemoptysis may occur, sometimes so profuse as to result in death. Early diagnosis is essential while the tumor is still operable. Tracheoscopy and contrast roentgenography are useful. Biopsy is important to establish the type. The prognosis is unfavorable. If the condition is not promptly treated the symptoms develop rapidly and suffocation, hemorrhage, bronchial and pulmonary infection and heart failure result in death.

The author advises extirpation by diathermy coagulation followed by deep roentgenotherapy. Insertion of radium is rarely successful. The use of the cyclotron and betatron has proved effective and has the advantage that the skin dose is small so that surface burns are avoided and the treatment can be concentrated on the deep-lying tissues.

HIGBEE.

## THROAT

### Papilloma of the Tonsil with Danger of Malignancy.

Sagra, C. M.: *Acta oto-rino-laringol., Ibero-Amer.*, 6:449-457, 1955.

The patient had suffered from tinnitus in the left ear for about four years accompanied by pulsation and almost constant frontal

headache with occasional clouding of vision. Valsava's test was negative in the right ear, Politzer's test negative on both sides. Pharyngeal examination revealed a cauliflower-shaped growth in the right tonsil about the size of a large pea. The growth was removed, with the adjacent chain of lymph nodes. An enlarged lymph gland was found in the posterior wall of the pharynx on the right side, and other small, mobile, painful nodes were palpable in the cervical region.

On histologic examination the extirpated growth was recognized as an epithelioma with cornification and hyperacanthosis.

Two months later the wound was irradiated to ensure against recurrence and to preclude the danger of malignancy. Suppuration occurred but the lesion healed in fifteen days. The tinnitus and vertigo did not recur. An audiogram revealed a loss of hearing of 35 per cent in the left ear.

In a second case a tumor the size of a pea in the right tonsil at the base of the pillars was dissected out with scissors. The growth resembled a papilloma and contained numerous fibroblasts, lymphocytes and plasma cells with spaces occupied by a mass of epithelioid cells. The latter were atypical. The centers were necrotic with open spaces where the cell tissue had been destroyed.

The diagnosis was fibroadenoma with considerable epithelioid proliferation indicating initial stages of malignancy. It was not possible to follow the later development of the case.

In both these cases there was considerable danger of malignancy. Tonsillar papillomas frequently develop into epitheliomas without warning symptoms. For this reason papillomas should be removed promptly. Histologic examination of all extirpated tissue is essential even when the tumor appears to be benign.

HIGBEE.

#### Tonsillitis and the Organism as a Whole. Physiopathologic Classification.

Rius, M.: *An. Oto-Rinolaringol., Uruguay* 24:4:152-163, 1954.

Tonsillar focal infection may be localized, chronic, isolated from other areas by scar tissue following an incomplete operation and cause a generalized infection. The surrounding tissues are poorly vascularized, so that organisms may remain indefinitely in the "dead spaces" without becoming more virulent. The responsible organism varies, but the *Streptococcus* is the most frequent agent. During periods of acute inflammation the organisms penetrate the crypts and accumu-

late on the surface. The most virulent and resistant forms are *Streptococcus hemolyticus* and *S. virosicus*. The less resistant *S. viridans* is generally found in dental infections.

The focal infection is subject to periodic exacerbations, according to the defensive power of the surrounding mesenchyma. Allergies may be hereditary or acquired, precipitated by a new allergin, or by several allergins. The degree of immunity developed by the parenchyma varis and may also be hereditary or acquired.

Chronic tonsillitis falls into various physiopathologic categories: 1) simple toxemia with asthenia and fever, without mesenchymal involvement; 2) toxemia with hyperergic mesenchymal stress in the form of rheumatic fever, cardiac involvement, arthritis and nephritis without specific bacteriemia. The *S. hemolyticus* in these cases is virulent and is resistant to antibiotics. Treatment consists of antiphlogistic agents such as salicylates, butazolidine, pryocatechol derivatives, ACTH and cortisone. In most cases there is a history of previous rheumatic involvement, occasionally of rheumatic cardiac insufficiency, renal disease, purpura, splenomegaly, a slight embolus, increased sedimentation time, with excess fibrin and mild leukocytosis. 3) Subacute bacteriemia may occur with anergic mesenchymal reaction and secondary foci due to *S. viridans*, which will respond to antibiotics. No antiphlogistic medication is necessary. There may be a history of painful rheumatic involvement, cardiac insufficiency, purpura, renal disease, splenomegaly, and increased sedimentation rate, with leukocytosis or leukopenia and anemia. 4) Acute septicemia, anergic mesenchyma, and secondary foci may be associated with peritonsillar inflammation or suppuration, fever, and angina. As a rule, *S. hemolyticus* is present and is resistant to antibiotics, especially if there is thrombophlebitis of the tonsillar blood vessels. The latter requires surgical intervention.

These four types are not clearly defined but overlap to some extent. Polyarticular inflammatory rheumatism with diffuse glomerular nephritis, uremia, pericarditis or myocarditis may be associated with tonsillar infection. In less severe cases the symptoms are relieved when the tonsils are removed by electrocoagulation. However, if the infection becomes generalized with severe renal or cardiac involvement a fatal outcome is frequent.

In young individuals cardiac lesions are more frequent, in older persons rheumatoid arthritis and ankylosis predominate.

In all cases, complete removal of the tonsillar focus is essential. If the operation is incomplete there is danger of residual infection and "closed foci." In cases of degenerative and metabolic rheumatic



disease, the tonsillar focus results in superimposed inflammation. Surgery is followed by improvement but does not cure the primary rheumatic disease.

HIGBEE.

### MISCELLANEOUS

#### Two Cases of Garcin's Syndrome.

*Cervellera, G., and Ruta, T.: Riv. oto-neuro-oftalmol. 30:396-404.*

This rare syndrome is marked by unilateral paralysis of the cranial nerves, without involvement of the central or pyramidal nervous system and usually without intracranial hypertension. The condition is almost always of neoplastic origin and is usually an extension of a malignant tumor of the rhinopharyngeal region, ear, maxillary sinus or of other areas in more or less direct connection with the base of the brain. Bone metastases, brain tumors, unilateral polyneuritis or meningitis are among the etiologic factors. The tumor develops by progressive invasion of the bone tissue without attacking the dural sheath. Paralysis of the cranial nerves results from pressure exerted by enlarged lymph nodes involved in the metastasis.

In one case cited, the initial symptoms were a sensation of unsteadiness, lasting for thirty minutes with visual disturbances and nausea. A fortnight later persistent tinnitus developed in the left ear followed by acute earache without fever and twenty-four hours later by a mucopurulent discharge from the ear which disappeared a few days later. The earache became less severe but did not cease completely. The symptoms recurred three times during the next few months. The continuous severe headache radiated into the entire left side, with involvement of the VI and VII nerves, paresthesia of the area innervated by the V nerve, dysphagia and slight fever. Tympanic paracentesis and intense treatment with antibiotics relieved the symptoms somewhat. Tests revealed hypoesthesia to pain and touch on the left side of the face, convergent strabismus due to paresis of the left abductor muscle and functional impairment of the facial nerves. Audiometric examination showed moderate decrease in acuity for frequencies above 2000 decibels in the right ear and severe loss of hearing in the left ear. At 4000 decibels hearing was zero. Wassermann and other tests were negative.

After surgical intervention the symptoms abated somewhat, but recurred with dysphonia and difficulty in swallowing, and paralysis



of the VI, VII, IX, X, XI and XII nerves on the left side, due to enlargement of the lymph nodes of the neck. On biopsy a large node was found in the carotid region which proved to be a metastatic carcinoma with highly undifferentiated cells.

The general condition deteriorated, vision was reduced on the left side and the cochleovestibular reflexes disappeared completely. Vertigo was continuous. The patient was in a serious condition when last seen.

The second patient had had typhoid fever two years before. Intense pain occurred in the right ear, radiating throughout the right side of the head and accompanied by discharge from the ear, vertigo, and paralysis of the right VII nerve, dysphagia, dysphonia, visual disturbances and general debility. Mastoidectomy relieved the symptoms somewhat but only temporarily. A year later otoscopic examination revealed a large, smooth, fleshy, bleeding mass in the right auditory passage with profuse purulent and bloody exudate. The right mastoid region was swollen and painful. A similar mass was found in the pharynx. The larynx was deviated, the vocal cords were thin and flaccid. Hearing was reduced on the right side. No nystagmus occurred in response to caloric stimulation. The V to XII cranial nerves on the right side were affected. Severe headache was present on the right side.

On removal the tumors in the mastoid and pharynx appeared to be nasopharyngeal fibromas. The patient left the clinic in serious condition. The tumors had the histologic appearance of benign fibromas but it is possible that such tumors are composed of cells in a stage of intermediate maturation. There is a strong probability that they will develop into fibrosarcomas.

HIGBEE.

#### A Case of Tumor of the Jugular Glomus, and a Possible Error in Diagnosis.

Roca de Vinals, A. J. M.: *Acta oto-rino-laringol., Ibero-Amer.*, 6:458-473, 1955.

Tumors of the glomus jugularis may be characterized histologically as paragangliomas developing at the expense of the paragangliar tissue normally present in the cupula of the bulb of the jugular vein, in the interior of the cupula of the bulb of the jugular vein, in the interior of the tympanum, around Jacobson's nerve or within the aditus. The symptoms vary with the location. Glomic tumors of the tympanum simulate catarrhal otitis, with pulsating tinnitus and deafness. As the tumor develops, suppuration, hemorrhage and vertigo occur and polyps form in the passage. In advanced stages neuro-

logic symptoms develop due to pressure on the nerve trunks crossing the foramen. Late symptoms are vascular, resembling aneurysm. Stereoscopic roentgenography is especially useful in establishing the diagnosis.

Tumors of the glomus can be distinguished from simple catarrhal otitis by the absence of rhinopharyngeal complications, by the permeability of the eustachian tube, by tinnitus synchronized with the pulse and by the evolution of the condition. If the ear drum is bulging and inflamed, acute otitis media may be suspected but can be excluded by the absence of actual earache and by the fact that the bulging involves only the posterior and lower portion. If the tumor is accompanied by discharge from the ear, fungous growths, bleeding polyps and pulsating tinnitus are usually present. Histopathologic examination of the polyps will conclusively establish the diagnosis.

In cases of tumor of the glomus the recommended treatment is extirpation of the growth followed by roentgenotherapy.

One case is cited of a benign tumor which was cured except for residual nerve deafness. In another case the following symptoms were present: facial paralysis, otalgia, headache, persistent vertigo, inflammation of the eardrum with slight bulging of the upper portion, nerve deafness, tinnitus, paralysis of the glossopharyngeal and vagus nerves, with recurrent velopalatal paralysis. There was no mastoid involvement. The eustachian tube was roentgenographically normal. Tumor of the jugular glomus was suspected and 22 x-ray treatments were given. The velopalatal paralysis disappeared but the other symptoms persisted. Paracentesis elicited no exudate. Biopsy of a fragment from the fundus of the tympanic cavity was negative. The vertigo was so marked that the patient could not stand or walk without falling. Finally, surgical intervention in the region of the posterior cranial fossa revealed a large encapsulated cerebellar abscess adherent to the dura mater adjacent to the foramen lacerum. Following complete removal of the abscess all the symptoms disappeared and the patient recovered completely, except for slight nystagmus toward the side of the lesion.

HIGBEE.

**Esophagoscopy in the Diagnosis of Cancer of the Cardial and Gastrojuxta-cardial Region.**

Ferrer, E. A.: *Acta Oto-Rino-Laringol. Ibero-Amer.* 6:4:233-260, 1955.

Clinical and roentgenographic examination and biopsy cannot always determine the extent, type, hemorrhagic tendency and degree

of stenosis in cardial cancer. Esophagoscopy is essential as a diagnostic aid. To explore the deep-lying gastrocardial region, a long, narrow, oval esophagoscope, 50 cm long, 7 by 13 mm in diameter is employed. The Henning esophagoscope has a terminal probe of transparent rubber which can be insufflated to distend the cardia and render the lesion more visible. This modern esophagoscope permits direct observation by means of a stereoscopic attachment, manipulation with forceps, irrigation, withdrawal of tissue for biopsy and of secretions by aspiration. Use of the stereoscope and also previous roentgenographic study, will eliminate the danger of rupturing the esophagus by the introduction of "blind" and rigid tubes into a malformed, diverticular or constricted passage. Intubation by Soutta's tube sometimes relieves the symptoms and obviates the necessity for gastrostomy. A hemostatic balloon may be introduced and inflated to stop hemorrhage and gradually dilate the constricted passage.

During difficult exploration, anesthesia by means of intravenous administration of curare or of barbiturates is helpful. During general anesthesia respiration must be maintained and controlled by means of another tube inserted in the larynx. The author employs general anesthesia only in cases of deformity, such as kyphosis or ankylosis of the cervical vertebrae, or when the psychological state of the patient requires it. Usually topical local anesthesia of the pharynx is sufficient. A morphine or scopolamin injection is given an hour previously. When local anesthesia is used the patient need not be hospitalized and the procedure is well tolerated.

The patient is in the supine position, with the head and neck elevated. The tube is introduced as far as possible into the esophagus between the posterior wall of the larynx and that of the hypopharynx, in the median line and into the cricopharyngeal opening of the esophagus. A spastic contraction of this opening is a protective reflex and indicates a cancerous or benign ulceration. The permeability of the upper sphincter of the esophagus can sometimes be restored by the introduction of a smooth sound through the esophagoscope to overcome the obstruction.

In cases of simple retention and fermentation of food the mucosa is smooth, edematous and the esophagus is dilated. In esophagitis resulting in regurgitation the mucosa is inflamed, eroded and ulcerous. The consistency of the lesion is diagnostic. Cancerous tissue is hard and resistant. By means of the esophagoscope the color, position, amount of bleeding and ulceration may be determined. If cancer is suspected, tissue should be removed for histologic examination.

Dysphagia is the most characteristic symptom in these cases. Other signs are a sensation of retrosternal congestion, sialorrhea, an-

gina, choking, regurgitation and hemorrhage. In nineteen cases the lesion was an adenocarcinoma, in eighteen, epithelioma and in seven it was not exactly diagnosed.

Treatment consisted in roentgenotherapy, gastrostomy, esophagogastrrectomy, esophagectomy and implantation of radium.

HIGBEE.

#### Study of Three Cases of Congenital Lateral Cervical Fistulae.

Polo, J. G.: *Bol. Españ. Otorrinolaringol. y Broncoesofagol.* 8:2:80-90, 1955.

The first patient, a woman 23 years of age, had noted since childhood an opening in the lower part of the left side of the neck, between the sternal and the clavicular insertions of the sternocleidomastoid muscle which exuded a viscous fluid. The orifice had closed temporarily several times, resulting in swelling and intense pain, and necessitating incision. For some time it had remained an open fistula. On palpation a thin, subcutaneous cord was noted, running from the opening to the hyoid and into the deeper tissues. Catheterization of the fistula elicited pain in the pharynx near the left tonsil. When a saline or sugar solution was injected into the fistula, the patient noted its presence in the pharynx and could detect its taste. When methylene blue was injected it could not be observed to enter the pharynx but contrast roentgenography was more revealing.

After dissecting the tract the postoperative condition was good except for slight edema of the pharyngeal mucosa.

In the second case, a man of 19 years, the fistula was on the right side. Otherwise the findings corresponded to those in the first case.

The third patient had frequently suffered from angina. A small orifice below the left submaxillary region exuded a thick serous material resembling pus. Palpation revealed a small swelling, but no fibrous cord as in the other cases. It was difficult to insert a probe and contrast material.

The father of the first patient also had two fistulae in the anterior wall of the neck, at the points of insertion of the sternocleidomastoid muscles. They had been present since childhood.

In all three cases, the operation was carried out under novocain-adrenalin anesthesia. The incision was made in the lower opening of the fistula and continued upward, following the anterior margin of

the sternocleidomastoid muscle to 2 cm above the hyoid bone. The lower extremity of the fistula was freed and a slender stylet with a button end was introduced with catgut or silk attached to the lower portion, to serve as a guide. The fistula was dissected out as far as the upper extremity. The dissection was continued as far as the pharyngeal mucosa, without rupturing the latter. The inner extremity was ligated, the fistulous tract severed and sutured.

The congenital lateral cervical fistulae are rare. Of nine patients observed by the author, seven were men and two women. The symptoms usually consist of acute pain, inflammation and discharge. Roentgenography with a contrast material is essential in determining the length, caliber and bifurcations of the fistulae. Abscesses, cysts, and indurated phlegmons sometimes develop and may block the external orifice of the fistula. There is also danger of malignancy. For this reason, as well as for cosmetic considerations, complete extirpation is advisable. The author has not encountered adhesions to the hyoid bone, although they have been reported by other surgeons. The etiology of these fistulae is unknown.

HIGBEE.



## SIXTH INTERNATIONAL CONGRESS OF OTOLARYNGOLOGY

### PRELIMINARY PROGRAM

SUNDAY, MAY 5, 1957

8:30 a.m.-4:00 p.m.

Registration, Presidential Ballroom, Hotel Statler  
Scientific and Technical Exhibits open  
Hospitality Lounge for Foreign Members open  
Ladies' Committee Hospitality Lounge open

5:00 p.m.

Convocation, Constitution Hall

6:00 p.m.

President's Reception and Buffet Supper, Pan American Union  
(Informal)

MONDAY, MAY 6

8:30 a.m.-5:00 p.m.

Registration, West Checkroom, Hotel Statler  
Exhibits open  
Hospitality Lounges open

*Open each day  
during  
these hours*

9:00 a.m.-12:00 noon

Plenary Session, Presidential Ballroom, Hotel Statler

CHRONIC SUPPURATION OF THE TEMPORAL BONE

Openers: PROF. MARCUS DIAMANT, Halmstad, Sweden  
Anatomical and Etiological Factors in Chronic  
Middle Ear Disease

PROF. LUZIUS RÜEDI, Zürich, Switzerland  
Pathogenesis and Treatment of Cholesteatoma  
in Chronic Suppuration of the Temporal Bone

PROF. HORST WULLSTEIN, Würzburg, Germany  
Surgical Repair for Improvement of Hearing  
in Chronic Otitis Media

Discussers: Mr. A. Tumarkin, F.R.C.S., Liverpool, England  
Prof. Juan Manuel Tato, Buenos Aires,  
Argentina

Mr. T. E. Cawthorne, F.R.C.S., London, Eng.  
Prof. Fritz Zöllner, Freiburg, Germany

Sightseeing tours in and about Washington (available daily)

MONDAY, MAY 6 (continued)

2:00-5:00 p.m.

General Sessions, 5 simultaneous sections (rooms to be designated)

Film Session, Presidential Ballroom

Sightseeing tours (available daily)

Medical tours to Walter Reed Army Medical Center  
Armed Forces Institute of Pathology  
Navy Medical Center, Bethesda, Maryland  
National Institutes of Health, Bethesda  
Forest Glen Speech and Hearing Center

(These tours available each afternoon)

8:00 p.m.

Reception and tour, National Gallery of Art



**TUESDAY, MAY 7**

9:00 a.m.-12:00 noon

General Sessions, 5 simultaneous sections

Film Session, Presidential Ballroom

Special all-day program for ladies including tour and luncheon

2:00-5:00 p.m.

General Sessions, 5 simultaneous sections

Film Session, Presidential Ballroom

Special ladies' program continued during afternoon

8:30 p.m.

Concert, Constitution Hall

Program of musical Americana

**WEDNESDAY, MAY 8**

9:00-9:30 a.m.

Special address, Presidential Ballroom

DOCTORS AS DIPLOMATS

Howard Rusk, M.D., Director, Institute of Physical Medicine  
and Rehabilitation, New York University-Bellevue Medical  
Center, New York

9:30 a.m.-12:30 p.m.

Plenary Session, Presidential Ballroom

COLLAGEN DISORDERS OF THE RESPIRATORY TRACT

Openers: PROF. HANS SELYE, Montreal, Canada  
Introduction

PROF. MICHELE ARSLAN, Padua, Italy  
The Upper Respiratory Tract

DR. LESLIE GAY, Baltimore, Maryland  
The Lower Respiratory Tract

Discussers: Sir Victor Negus, London, England  
Prof. Branimir Gusic, Zagreb, Yugoslavia  
Dr. Aubrey G. Rawlins, San Francisco,  
California, U.S.A.  
Dr. Henry L. Williams, Rochester, Minnesota,  
U.S.A.

2:00-5:00 p.m.

General Sessions, 5 simultaneous sections  
Film Session, Presidential Ballroom

5:00-6:00 p.m.

Business meeting, International Committee (Official Delegates)

6:00-7:00 p.m.

Dinner for Official Delegates and wives, South American Room  
(formal)

THURSDAY, MAY 9

9:00 a.m.-12:00 noon

General Sessions, 5 simultaneous sections  
Film Session, Presidential Ballroom

2:00-5:00 p.m.

General Sessions, 5 simultaneous sections  
Film Session, Presidential Ballroom

7:00-8:00 p.m.

Congress cocktail party, Sheraton-Carlton Hotel

8:15 p.m.

Grand Banquet, Presidential Ballroom and Congressional Room,  
Statler Hotel (formal)

**FRIDAY, MAY 10**

9:00 a.m.-12:00 noon

Plenary Session, Presidential Ballroom

**PAPILLOMA OF THE LARYNX**

Openers: **PROF. JO ONO**, Tokyo, Japan

Etiology

**PROF. PLINIO DE MATTOS BARRETTO**, Sao Paulo,  
Diagnosis Brazil

**MR. F.C.W. CAPPs**, London, England

Therapy

Discussers: **Prof. C. A. Hamberger**, Göteborg, Sweden

**Dr. Pedro Hernandez Gonzalo**, Havana, Cuba

**Prof. Eelco Huizinga**, Groningen, Netherlands

**Prof. Albert von Riccabona**, Vienna, Austria

2:00-5:00 p.m.

General Sessions, 5 simultaneous sections

Film Session, Presidential Ballroom

The following activities will be scheduled every day:

8:30-5:00

Registration

Scientific Exhibits

Technical Exhibits

Hospitality Lounge for Foreign Members

Ladies' Committee Hospitality Lounge

Morning and afternoon

Hours to be announced

Sightseeing tours

Each afternoon

Hours to be announced

Medical tours

## Notices

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### ACADEMY HOME STUDY COURSES

The 1956-1957 Home Study Courses in the basic sciences related to ophthalmology and otolaryngology, which are offered as a part of the educational program of the American Academy of Ophthalmology and Otolaryngology, will begin on September 1 and continue for a period of ten months. Detailed information and application forms can be secured from Dr. William L. Benedict, the executive secretary-treasurer of the Academy, 100 First Avenue Building, Rochester, Minnesota. Registrations should be completed before August 15.

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### AMERICAN LARYNGOLOGICAL ASSOCIATION

Copies of the Transactions of the American Laryngological Association are available for general distribution at \$8.00 a copy. Please send request with check to:

Dr. Edwin N. Broyles,  
Editor Transactions  
1100 North Charles St.  
Baltimore 1, Md.

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### TULANE UNIVERSITY OF LOUISIANA SCHOOL OF MEDICINE

The three year residency in otolaryngology offered at Charity Hospital of Louisiana at New Orleans on the Tulane University of Louisiana School of Medicine service is designed to qualify the holder

for the examinations of the American Board of Otolaryngology and the practice of all phases of otolaryngology and endoscopy.

Candidates must be graduates of a class A medical school and must have completed a minimum of one year of general internship. An additional year of residency in internal medicine or general surgery is desirable but not essential.

All work is under the direct supervision of members of the Tulane Department of Otolaryngology, who are also members of the Charity Hospital Otolaryngological Staff; they are available at all times for instruction and guidance. Basic sciences are offered throughout each year of the residency during the academic year. The resident also participates in the program of the Speech and Hearing Center at the Tulane University School of Medicine.

The hospital year extends from July 1 of one year to June 30 of the following year.

Applications should be addressed to the Chairman of the Department of Otolaryngology, Tulane University of Louisiana School of Medicine, 1430 Tulane Ave., New Orleans 12, Louisiana.

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#### UNIVERSITY OF ILLINOIS

The next course in Laryngology and Bronchoesophagology to be given by the University of Illinois, College of Medicine, is scheduled for the period November 5 through November 17, 1956. The course is under the direction of Dr. Paul H. Holinger.

Interested registrants will please write directly to the Department of Otolaryngology, University of Illinois, College of Medicine, 1853 W. Polk Street, Chicago 12, Ill.

Interested physicians should write direct to the Department of Otolaryngology, 1853 West Polk Street, Chicago 12, Illinois.

## THE NINTH ANNUAL CONFERENCE ON ELECTRICAL TECHNIQUES IN MEDICINE AND BIOLOGY

The Ninth Annual Conference on Electrical Techniques in Medicine and Biology will be held at the Governor Clinton Hotel in New York City on November 7, 8, and 9, 1956.

The Conference is sponsored by the American Institute of Electrical Engineers, the Institute of Radio Engineers, and the Instrument Society of America. In addition to the technical sessions, there will be field trips to installations of interest to those attending.

Titles and brief abstracts for proffered papers may be submitted to the Conference Chairman, E. Dale Trout, General Electric Company, X-Ray Department, Milwaukee 1, Wisconsin.

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## ANNALS OF OTOTOLOGY, RHINOLOGY AND LARYNGOLOGY

In order to complete the interrupted files of some foreign libraries, the ANNALS will buy from subscribers, at \$1.50 per copy, a certain number of the following issues now out of print. Please communicate with the Business Manager, ANNALS OF OTOTOLOGY, RHINOLOGY AND LARYNGOLOGY, P. O. Box 1345, Central Station, St. Louis 1, Mo., U.S.A.

|                                       |                |
|---------------------------------------|----------------|
| March 1940                            | March 1950     |
| March 1944                            | March 1951     |
| March, June, September, December 1945 | March 1952     |
| March, September 1946                 | March 1953     |
| September 1947                        | March 1955     |
| March, December 1948                  | June 1955      |
| March 1949                            | September 1955 |

# OFFICERS

## OF THE

### NATIONAL AND INTERNATIONAL OTOLARYNGOLOGICAL SOCIETIES

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#### VI INTERNATIONAL CONGRESS OF OTOLARYNGOLOGY

President: Arthur W. Proetz, M.D., St. Louis, U. S. A.

Secretary-General: Paul H. Holinger, M.D., 700 North Michigan Ave., Chicago 11, Ill., U. S. A.

Meeting: Washington, D. C., May 5-10, 1957.

#### INTERNATIONAL BRONCHESOPHAGOLOGICAL SOCIETY

President: Dr. Theodor Hünemann, Düsseldorf

Secretary: Dr. Chevalier L. Jackson, 3401 N. Broad St., Philadelphia 40, Pa.

Meeting: Philadelphia, May 12 and 13, 1957.

#### PAN-AMERICAN ASSOCIATION OF OTO-RHINO-LARYNGOLOGY AND BRONCHO-ESOPHAGOLOGY

President: Dr. Jose Gros, Havana

Secretary: Dr. Chevalier L. Jackson, 3401 N. Broad St., Philadelphia 40, Pa.

Meeting: Sixth Panamerican Congress, Brazil, 1958 or 1959

#### AMERICAN ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. Algernon B. Reese, New York.

Executive Secretary: Dr. William L. Benedict, Mayo Clinic, Rochester, Minn.

#### AMERICAN BOARD OF OTOLARYNGOLOGY

President: Dr. Gordon D. Hoople, Syracuse, N.Y.

Secretary: Dr. Dean M. Lierle, University Hospital, Iowa City, Iowa.

Next examination: Chicago, October 8-11, 1956.

#### AMERICAN BRONCHO-ESOPHAGOLOGICAL ASSOCIATION

President: Dr. Clarence W. Engler, Cleveland, O.

Secretary: Dr. F. Johnson Putney, 1719 Rittenhouse Sq., Philadelphia 3, Pa.

Meeting: None, in 1957.



**AMERICAN LARYNGOLOGICAL ASSOCIATION**

President: Dr. LeRoy A. Schall, Boston.

Secretary: Dr. Harry P. Schenck, 326 South 19th St., Philadelphia, Pa.

Meeting: Hotel Statler, Washington, D.C., May 3, 1957.

**AMERICAN LARYNGOLOGICAL, RHINOLOGICAL AND OTOLOGICAL SOCIETY, INC.**

President: Dr. Dean M. Lierle, Iowa City.

Secretary: Dr. C. Stewart Nash, 708 Medical Arts Bldg., Rochester, N. Y.

Meeting: Section meetings only in 1957.

**AMERICAN MEDICAL ASSOCIATION, SECTION ON LARYNGOLOGY, OTOTOLOGY AND RHINOLOGY**

Chairman: Dr. John R. Lindsay, Chicago, Ill.

Secretary: Dr. Hugh A. Kuhn, Hammond, Ind.

**AMERICAN OTOLOGICAL SOCIETY**

President: John R. Lindsay, M.D., Chicago.

Secretary-Treasurer: Lawrence R. Boies, M.D., University of Minnesota Hospitals, Minneapolis 14, Minnesota.

Meeting: Hotel Statler, Washington, D.C., May 4, 1957.

**THE AMERICAN SOCIETY OF OPHTHALMOLOGIC AND OTOLARYNGOLOGIC ALLERGY**

President: Dean McAllister Lierle, M.D., University Hospital, Iowa City, Iowa.

Secretary: Michael H. Barone, M.D., 468 Delaware Avenue, Buffalo 2, New York.

**PACIFIC COAST OTO-OPHTHALMOLOGICAL SOCIETY**

President: H. Leroy Goss, M.D., 620 Cobb Building, Seattle 1, Wash.

Secretary-Treasurer: Homer E. Smith, M.D., 508 East South Temple, Salt Lake City, Utah.

Meeting: Coronado, California, April 7-11, 1957.

**CANADIAN OTOLARYNGOLOGICAL SOCIETY**

President: Dr. G.M.T. Hazen, 208 Canada Bldg., Saskatoon, Sask.

Secretary: Dr. G. A. Henry, Medical Arts Bldg., Suite 328, Toronto, Ont.

Meeting: Banff Springs Hotel, June 17, 18 & 19, 1957

**THE SOCIETY OF MILITARY OTOLARYNGOLOGISTS**

President: Col. Wendell A. Weller, 3810 USAF Hospital, Maxwell AFB, Alabama

Secretary-Treasurer: Major Stanley H. Bear, M.C., 3810th USAF Hospital, Maxwell AFB, Alabama

Meeting: Palmer House, Chicago, Illinois, October 16, 1956



